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THE

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THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle,
Ceylon.

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THE TEA QUARTERLY
VOLUME XXIX. MARCH, 1958. PART I

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COMMENT

The present issue of the *Tea Quarterly* appears after a long interval, and it is possible that in the near future numbers may not be as frequent as expected. The majority of readers will be aware that the reason for this condition is to be found in the temporary shortage of staff. Under the circumstances we consider it preferable to reduce the quantity of publications in order to maintain a desirable standard.

Certain of the articles in this issue are of a more technical nature than usual. We do not intend to present research papers, but we feel that it may be of interest to those concerned with the grim realities of tea production to appreciate that the scientist also has very real problems to contend with, before his work can be translated into practical advice.

We would draw readers' attention to the length and complexity of some of the preliminary experiments which are recorded. Bearing in mind the necessity for much larger experiments if we are to attempt to solve present and future problems, we hope that the following papers will serve to increase the understanding between the Industry and the Institute.

Note: Parts I & II of *Tea Quarterly* for 1957 complete Volume XXVIII.

A DISCUSSION ON THE RELATION BETWEEN QUALITY AND MANURING

J. A. H. Tolhurst

At the time of going to press the indications were that the 1957 exports of tea from Ceylon would be approximately 400 million pounds, as compared with 348 million in 1956, 298 million in 1950 and 287 million only ten years ago, in 1947.

It was also apparent that this latest record-breaking achievement was viewed with a rather jaundiced eye, since in the latter part of 1957 there had been a tendency for prices to fall below desirable levels. Fears were expressed that a continuation of the upwards trend of acreage yields of tea would be accompanied by a reverse trend of price levels. In recent years the industry in Ceylon has very generously given credit to the Institute for a proportion of the great expansion in crop production which has occurred and the Institute has been happy to think that its efforts have met with such success. Conversely, we should be prepared to face criticism, because if we had been guilty of building cardboard castles we should have much to answer for.

Since 1945, in particular, the industry and the Institute have worked together with a great unanimity of purpose, namely, to increase yields as rapidly as is consistent with good agricultural practice. We have no hesitation in saying that often the pace has been set by the Industry itself, and in one instance, to be related below, the Institute was virtually carried along in the slipstream. Nor has the Industry been at all reluctant to incur expenditure which may have been devoted very largely to building up reserves for the future, in the form of enhanced bush vigour and enriched soil fertility. We may say that, in general, tea plantations in Ceylon today present an encouraging picture with their potential crop producing capacity by no means reached. To this extent the Industry and the Institute can claim to have done their work well.

We do not want to take this discussion into the realms of world trade, although the agricultural scientist must make himself aware of what happens to the crop which he has helped on its way to the markets. We are concerned to answer two criticisms which have recently had considerable publicity and which have not always been kept as distinct as we might wish.

Do higher acreage yields of tea necessarily entail a lower standard of quality?

Do increased applications of inorganic fertilisers necessarily entail a lower standard of quality?

We are content to assume that recent depressions in market prices were in fact due to quality which was below average, and we will not attempt to define "standard of quality." We accept the statements of those experienced in these matters. The broader implications in these questions, however, certainly come within our purview, and we regret that circumstances beyond our control prevented a report from being published at the time when public discussion was actively concerned with this subject.

Do higher acreage yields of tea necessarily entail a lower standard of quality?

The frequency and intensity of plucking have for so long been recognised as factors of supreme importance governing the quality of the green leaf, and hence to

a large extent the quality of the made tea, that it may seem superfluous to head the discussion with these two points. Presumably it is recognised that if labour conditions on a given estate are such that an average yield of, say, 800 lbs. of made tea per acre can be plucked to a good standard, then an attempt to increase the yield to, say, 1,000 lbs. per acre will necessitate a lower standard of plucking. This latter figure has been quoted deliberately, and provides the scientist with a legitimate reason for commencing on a seemingly exclusively "practical" problem.

Thus, in recent years the scientists of the Institute have been faced with many queries regarding the yield potentialities of individual fields, and it is our considered opinion that the figure of 1,000 lbs. per acre has come to be regarded as a prestige target, and that no effort should be spared to reach and exceed the magic. While agreeing that this level of production is by no means high, and that our research projects are planned to cope with yields two or three times as great, we are quite emphatic in saying that some tea is not yet capable of giving 1,000 lbs. per acre without detriment to the bush. If such a yield is taken from, as opposed to being given by, such tea, the well-known cycle of deterioration sets in. Insistence on the extra hundred pounds before the soil and the bush are in a fit state of vigour can only lead to plucking for bulk to the detriment of quality. The answer is obvious, and is unfortunately a most unpopular one at times when market prices are low: money must be spent on building up the cropping capacity of the bush if it is desired to take high and increasing yields of good quality leaf.

The third aspect of the plucking problem concerns the rush periods, and although the scientists are not answerable for the weather conditions producing the surge of flush, they have a lively interest in the results. Apart from the almost certain lowering of plucking standards during these rush periods, it seems probable that such leaf could not produce tea of the highest quality, however carefully manufactured. And how carefully can it be manufactured on some estates, where the factory was designed for the crop levels which were normal many years ago? We are aware from our advisory contacts, that not all factories can be said to follow ideal manufacturing principles during the normal cropping months, owing to inadequate space and machinery. Many more will come to grief during the rush period, and the made tea which results from trying to "squeeze a quart into a pint pot" will suffer, in exactly the way predicted by scientists. We have expended and will continue to expend, much energy on our insistence that as long as the system of manufacture remains as it is at present there will be the necessity to increase factory facilities at a much greater rate than has been practised in recent years. We are aware that this answer is obvious enough, and as likely to be as unpopular as our remarks on cropping capacity.

Here, however, there may in time be an alternative solution. It is conceivable that different manufacturing systems may be evolved, based on a full biochemical knowledge of the processes involved. This would require very little expenditure by the industry, in the form of increased research facilities at the Institute, but even with the best working conditions which money could provide, the scientists could only hope for a profitable revolution in manufacture after many years of intensive work.

The conclusions under this heading would seem to be that the scientists cannot offer appreciable assistance to the Industry on the general problems associated with crop increase, unless the industry is able to help itself in certain ways which are outside the scope of science. One exception to this statement should be given due publicity: in those areas where blister blight occurs it is no longer necessary to avoid pruning so that recovery takes place during the monsoon, as the Institute's recommendations will afford perfectly satisfactory protection, and we may claim to have helped a little by offering one way to thin out rush crops.

Do increased applications of inorganic fertilisers necessarily entail a lower standard of plucking?

The previous discussion was intended to clarify serveral points which had no necessary association with the question of manuring, and to ensure that this question, complex enough in itself, could be investigated on its own. Inorganic fertilisers constitute virtually all the manure used in Ceylon tea, and unless otherwise stated the word "manure" will refer to this group of compounds, some of them made by man, others of natural origin, but all of them of a dry, powdery nature and lacking the dark colour combined with a moist or even adhesive consistency which characterises the majority of the organic manures. It is perhaps natural to assume that a bulky organic substance will be more acceptable to a growing plant than a desiccated mixture from a bag, but without delving into this favourite argument we may say that we were alarmed at the readiness with which inorganic manure was attacked by certain quarters, as soon as a marked fall in tea prices occurred.

Ceylon tea soils are not inherently rich in nutrients, and the only economic means of making good the deficit is to use balanced inorganic manures. Over the last ten years it has been proved on estate after estate, that the response to manuring is extremely high, and that bush vigour can be improved at the same time that yields can be increased. Soil deficiencies of specific nutrients have appeared in recent years, and the warnings which the Institute has given in regard to these should never be forgotten. Once such deficiencies have made themselves felt, then there is no alternative but to manure against them. It may be tempting to assume that the soil in one particular district is richer than elsewhere, and that the prospect of a nutrient deficiency occurring there is remote. We suggest that any tendency to think along these lines, which fortunately has not so far appeared, should be resisted. It is not good agricultural practice to wait for a deficiency to show itself, as the remedy is often more expensive than routine prevention.

We have deliberately avoided naming individual nutrients, because we wish to emphasise the general principle that manuring must be done with a balanced mixture. Any decrease or increase must affect all nutrients similarly. The balanced manures which we recommend, for mature tea, remain as:

T. 500, with slight variations

Dolomite.

IN ANY PUBLICATION FROM THE INSTITUTE A REFERENCE TO, SAY, 43 LBS. OF NITROGEN (N) MUST BE TAKEN TO MEAN "THAT WEIGHT OF T. 500 MANURE (OR VARIATIONS) WHICH WILL CONTAIN 43 LBS. OF NITROGEN."

The empirical arrangement whereby manure is applied according to yield has served the Industry very well, and the Industry itself must take credit and responsibility for fostering what is generally known as "the 10 lb. ratio". That is, manure at the rate of 10 lb. of nitrogen per 100 lb. of made tea. The Institute encouraged this ratio, because practice showed that it was capable of allowing the improvements in bush vigour and yield which, in recent years, were demanded by all who had an interest in Ceylon tea production. We had no statistically designed experiment to give a more precise evaluation of the effects of this 10 lb. ratio; such an experiment would have required at least fifteen years to give an answer. Nor do we feel the need of such proof at this stage. An intelligent appraisal of the actual results, which have come from the use of the 10 lb. ratio under every conceivable variation of cultural conditions, can surely be taken as sufficient evidence that the 10 LB. RATIO OF MANURING OF MATURE TEA IS, UNDER THE MAJORITY OF CONDITIONS, AN EXPANSION RATIO.

The 8 lbs. ratio as given in the Institute's Pamphlet No. 1, remains as A MAINTENANCE RATIO under most conditions. The difference between these ratios has not always been appreciated, but there should be no difficulty in adjusting a manuring programme to suit requirements, under average conditions, and for mature tea. It is hoped that the origin of the 10 lb. ratio has now been explained, and that it will no longer be suggested that this ratio is the normal one recommended by the Institute.

Our interest here lies in the possibility of an effect on quality of the made tea, arising from the 25% difference in bulk of manure used under these two ratios. Again we must turn to the findings of a large number of estates. Provided that the conditions mentioned in the first section of this article have been met, *i.e.* that harvesting and manufacture have been of a high standard, there has been no evidence that the higher ratio of manuring has affected quality.

Yet another possibility arises as yields increase, and which need not be associated with the question of ratios of manuring. The total quantity of manure applied per acre per annum also increases with the yield. We would suggest that, to date, there has been no relation between the intensity of manuring and quality of the made tea, and we believe that there are sufficient estates which produce tea of the very highest quality under such conditions of manuring to support our contention. We have qualified this remark because we are not happy about the future effects of high intensity manuring on soil conditions. This is not the place to go into details, except to say that, with the future target of 2,000 to 3,000 lbs. of made tea per acre from selected clones, our energies must be devoted to the maintenance of proper soil conditions and high quality of the tea, regardless of the manuring intensity. This is an immediate problem for the scientist, but we see no reason for the industry to worry for many years to come. If research is able to proceed unhindered there should, of course, be no need for concern at any time.

One final point from among the many which need to be investigated concerns the frequency of application of manure. This will presumably affect the efficiency of utilization of manure, and this will be a most important consideration in the future. The relevance here lies in the fact that if a very heavy annual dose of manure were to be applied in one application, the effect on the flush for a few plucks afterwards might be to produce something similar to tipping leaf in quality. The overall effect on an estate's manufacturing reputation would be negligible, but there is the possibility that high intensity manuring may be criticised on this basis. We maintain that this would be unjustified. There is sufficient physiological reason to encourage the division of the annual manure dose into two or three applications, and possibly four, and there should be no necessity for the artificial production of rush crops.

Conclusion.

Very briefly, we may say that there is no evidence to show that manure, used according to the above suggestions, has an adverse effect on the quality of tea, provided that estate conditions are such that crops can be harvested and manufactured properly.

Manure applications should *not* be timed to increase seasonal rush crops.

Recovery from pruning should not be handicapped by lack of manure, even though this may mean that the tipping leaf is increased in bulk.

An appreciation of the 8 and 10 lb. ratios, so-called, could lead to a useful flexibility in manuring programmes.

We see no reason to reduce manure applications, as long as an estate can produce good quality tea at a profit. A 10 lb. ratio is perfectly acceptable and no fears should be entertained in its use. The scientists have the long term effects under study.

BLISTER BLIGHT CONTROL IN 1957 WITH RESPECT TO FUNGICIDAL FORMULATION, APPLICATION RATES AND YIELD

T. Visser, N. Shanmuganathan and J. V. Sabanayagam

1. Introduction

In trials at St. Coombs, during the South West monsoon season of 1957, a number of proprietary brands of copper fungicides and organic preparations were tested for the control of blister blight with the following objects in view:—

(*a*) To compare the relative efficiency of the various preparations with a standard 50 per cent cuprous oxide.

(*b*) To ascertain whether satisfactory protection can be achieved by reducing the rate of application to 3 oz. after ten rounds at 6 oz. per acre.

(*c*) To explore conditions under which the different fungicides might give adequate control of blister blight at reduced dosages in comparison with the normal rates.

(*d*) To compare the indirect effect, if any, of the fungicides and their rate of application on the yield of tea in relation to blister blight incidence and possible phytotoxicity.

2. Experimental

2.1 Weather conditions.—In the table below, rainfall and sunshine data during the months the experiments were carried out are given together with the monthly averages over the 10 previous years (1946-1956).

Month	No. of rainy days		Rain in inches/day		Hours sunshine/day	
	1957	Average 1946-56	1957	Average 1946-56	1957	Average 1946-56
May	19	17.0	0.32	0.26	5.25	5.53
June	23	25.7	0.36	0.51	3.98	2.64
July	24	25.0	0.41	0.32	3.03	3.28
August	20	25.0	0.24	0.31	3.07	3.35
September	15	20.8	0.13	0.29	6.03	4.52
October	16	20.3	0.30	0.30	5.54	4.55
Avg /Month	19.5	22.3	0.29	0.33	4.48	4.00

The above rainfall and sunshine figures indicate that the weather during the South West monsoon of 1957 had been somewhat less severe than the average over the past 10 years, notably during June and September, the weather during July was slightly more severe than average.

2.2 Lay-out of the trials.—Fields No. 3, 8, 9 and 10 were chosen for the trials on St. Coombs estate. An area in each of these fields was divided into 3 blocks. The blocks were sub-divided into plots according to the number of treatments; blocks and plots were separated by guard rows.

Plot size of the experiments in fields No. 3, 8 and 9 was 400 bushes (about 1/8th acre), plot size in field No. 10 was 100 bushes (about 1/32nd acre). At the time spraying commenced field No. 3 was 40 months, field No. 8 was 17 months and fields No. 9 and 10 were 23 months from pruning.

2.3 Spraying.—The spray fluids were applied using a Birchmeier knapsack sprayer, care being taken to distribute the fluid over the plots as uniformly as possible. The volume of fluid applied was approximately 15 gallons per acre per round for all sprays at rates varying between 3 oz. and 8 oz. of fungicide. With certain fungicides the normal rate, 6 oz. or 8 oz., was reduced to half that amount after 10 rounds. Spraying was carried out at 9 to 10 days intervals on the day following plucking. The first spraying in fields No. 3, 8 and 9 was done well in advance of the monsoon rains, whereas spraying in field No. 10 was carried out after the monsoon had already set in.

2.4 Assessment.—Blister blight infection was assessed either on the day before, or on the day of plucking. A similar method was followed as in previous experiments (11, 18). The assessment was made by selecting at random 9 bushes in each plot at each date of inspection. Subsequently *all* the shoots plucked from these bushes (between 50 and 200) were examined for lesions on the third leaf; any spot from the "translucent stage" up to a fully formed blister was defined as a lesion.

The total number of lesions found on these leaves and the "percentage blister blight infection" were determined. This latter percentage is the number of shoots per 100 whose third leaves carried blisters. The correlations between these two standards of assessment were (over 14 plucks) the following: in field No. 3 for unprotected plots 0.904, for Perenox sprayed plots 0.927, for Fitox sprayed plots 0.965; the correlations for corresponding plots in field No. 10 were 0.883, 0.953 and 0. 920 respectively. As these correlations are all highly significant, only the percentage infected shoots (3rd leaves) has been given as a measure of blister blight incidence in the figures and tables to follow. The mean infection at each date was determined from the individual assessments on each plot (each treatment thrice replicated).

The "yield per treatment" consisted of the total flush plucked from the three plots over the experimental period and was expressed in lb. made tea. The latter was determined on the basis of the dry weights of two samples collected at each pluck (at 9-10 day intervals).

The data concerned with spraying and plucking of the fields are as follows:—

Field No. 3. 1st assessment 9th May, 1st spray 10th May, 1st pluck 5th June; experiment discontinued 30th September.

Field No. 8. 1st assessment 11th May, 1st spray 13th May, 1st pluck 8th June; experiment discontinued 2nd October.

Field No. 9. 1st assessment 14th May, 1st spray 16th May, 1st pluck 11th June; experiment discontinued 5th October.

Field No. 10. 1st assessment 20th June, 1st spray 21st June, 1st pluck 26th July; experiment discontinued 20th November.

Certain fungicides in the different fields were reduced to half the rate after the 10th round; on 30th July, 1st August, 3rd August and 18th September in fields No. 3, 8, 9 and 10 respectively.

2.5 Fungicides.—The fungicides used in the different field trials are given below in alphabetical order:—

(*a*) *Bordeaux mixture:* Freshly prepared from crystalline copper sulphate and hydrated lime (25.5 per cent metallic copper); applied at 4 oz. and 8 oz. per acre in field No. 3.

(*b*) *Cobredon:* A wettable powder of copper carbonate, containing 45 per cent copper by weight, applied at 3 oz., 6 oz./3 oz. (6 oz. reduced to 3 oz. after the 10th round) and 6 oz. in field No. 9 and at 6 oz. per acre in field No. 10.

(*c*) *Copper Sandoz:* A wettable powder in the form of copper oxide, containing 50 per cent copper by weight; applied at 3 oz., 4 oz., 6 oz./3 oz. and 6 oz. per acre in field No. 3.

(*d*) *Cupravit blue:* A dispersible preparation of copper oxychloride containing 35 per cent copper by weight; applied at 4 oz. and 8 oz. per acre in field No. 9.

(*e*) *Duphar colloidal copper:* A colloidal formulation of copper oxychloride containing 400 g. per litre (26 per cent by weight); applied at 3 oz., 6 oz./3 oz. and 6 oz. per acre in field No. 10.

(*f*) *E.F.* 250*:* A wettable powder formulation of copper acetyl acetone; applied at 4 oz. and 6 oz. levels in field No. 8.

(*g*) *Fitox:* A "coated" form of wettable powder of copper oxychloride initially containing 12 per cent copper, changed over by the end of July to a formulation containing 16 per cent copper by weight; applied at a rate of 8 oz. in fields 3, 8 and 10.

(*h*) *Flit* 406*:* A 50 per cent wettable powder formulation of Captan (orthocide); applied in field No. 10 at 4 oz. and 8 oz. per acre.

(*i*) *Perenox:* A dispersible preparation of yellow cuprous oxide containing 50 per cent copper by weight; applied at 4 oz., 6 oz./3 oz. and 6 oz. per acre in field No. 3 and as a standard at 6 oz. in fields No. 8, 9 and 10.

(*j*) *Phthalic* (Compound 4444a): A phthalic acid derivative containing 50 per cent of the organic active; applied at 4 oz. and 8 oz. levels in field No. 9.

(*k*) *Red Copper:* A dispersible form of cuprous oxide containing 70 per cent copper by weight ("Bayers" compound 4521); applied at 4 oz., 6 oz./3 oz. and 6 oz. per acre in field No. 8.

(*l*) *Shell Copper:* A dispersible formulation of copper oxychloride containing 50 per cent copper by weight; applied at 4 oz. + 2 oz. Tenac, 6 oz./3 oz. and 6 oz. per acre in field No. 3.

3. Results of the experiments

1. The average percentage of shoot infection over the main period (14 assessments) and the total yield over the same period in lb. made tea/1,200 bushes over 14 plucks are presented in block diagrams for the different fields in figure 1. These diagrams do not contain the figures obtained in plots in which the normal level of fungicides was reduced to half after 10 rounds (see table 1).

The observations to be made on the trials are the following:—

Field No. 3 (see figure 1A). The protection, as indicated by the percentage of infection, afforded by Perenox, Copper Sandoz and Shell Copper applied at lower rates (3 oz. and 4 oz.) was nearly as good as that given by 6 oz./acre. However, during the period of the heaviest blister blight infestation the lower dosages afforded statistically significantly less protection than the normal rates. Shell Copper at 4 oz. plus 2 oz. Tenac did not appear to give better protection than Perenox and Sandoz at 4 oz. without a special sticker. Fitox at 8 oz. gave considerably less protection over the entire period in comparison with the 50 per cent oxide or oxychloride, even if the latter were applied at 3 oz./acre.

It would seem that the total amount of metallic copper applied mainly determines the infestation level, as shown by plots sprayed with Fitox at 8 oz. and Bordeaux mixture at 4 oz.—in both cases about 1 oz. Cu/acre—show equal infestation (see also p. 12).

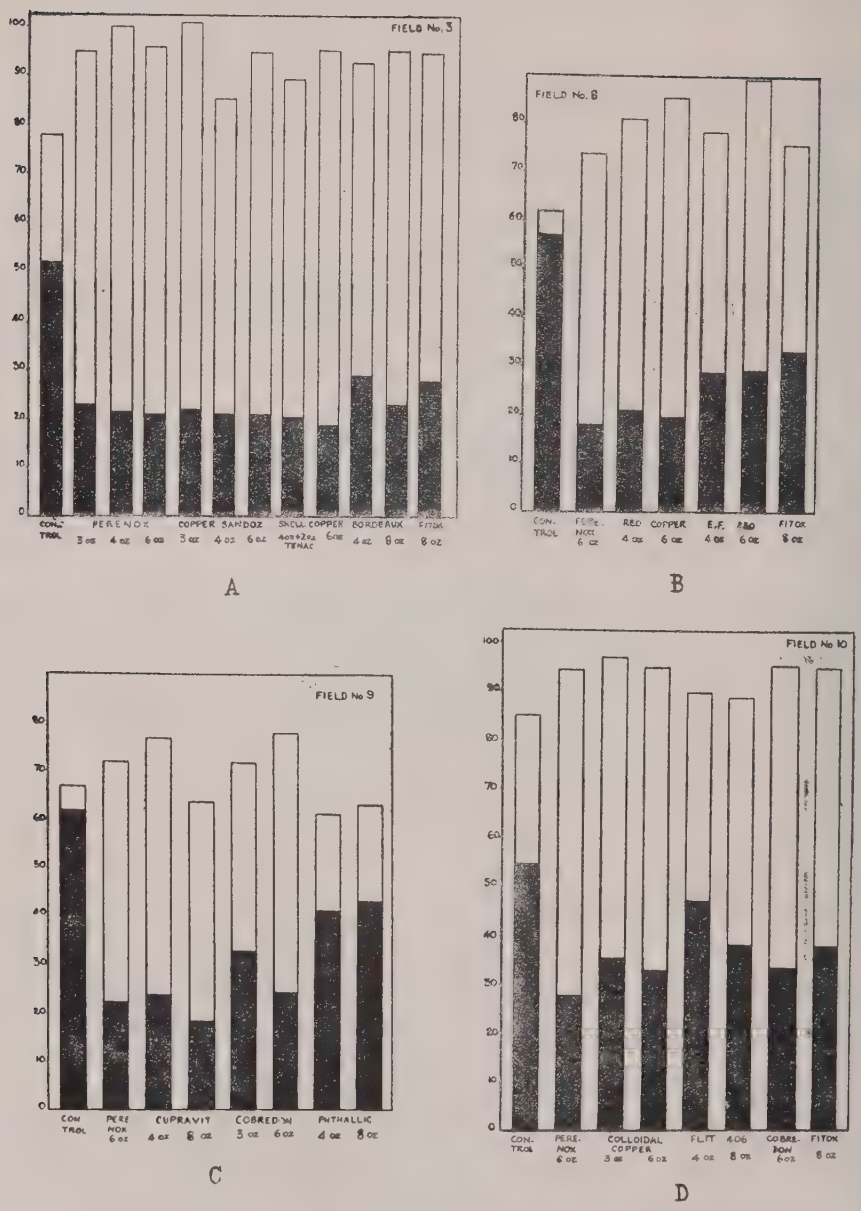


Figure 1. *A, B, C, D. Average blister blight infection and yield with regard to fungicide applied and rate of application.*

The *black* part of the columns indicates % blister infection; the total column, yield in lb. made tea/14 plucks/1200 bushes.

The level of infection found on plots sprayed with Bordeaux mixture at 8 oz. was comparable with that of plots sprayed with 4 oz. of the three standard fungicides.

The total yields given by the sprayed plots did not differ significantly from each other; they were significantly higher than that of the control in most instances.

Field No. 8, (see figure 1B). The average percentages of infection observed in plots sprayed with Perenox at 6 oz., Red Copper at 4 oz. and 6 oz. did not significantly differ. Both E.F.250 at 4 and 6 oz. and Fitox at 8 oz. gave significantly less protection than the former.

The yields of the sprayed plots varied to some extent, *e.g.* E.F.250 at 6 oz. giving a significantly higher yield than Perenox at 6 oz. The yields of all the protected plots (except in the case of Perenox) were significantly higher than that of the control.

Field No. 9, (see figure 1C). Cupravit blue at 8 oz./acre gave significantly better protection than all other treatments; Cobredon at 6 oz. was not appreciably different from Perenox at 6 oz. with regard to protection. Phthalic both at 4 and 8 oz. provided significantly less protection than Perenox at 6 oz. Cupravit at 4 oz. gave protection as good as Perenox at 6 oz. but Cobredon at 3 oz. was less satisfactory.

The variations in yield were fairly large, some of the treatments yielding even less than the control. None of the differences with the control, except for Cupravit at 4 oz., were statistically significant.

Field No. 10, (see figure 1D). The average infection recorded on the plots sprayed with Perenox at 6 oz. was significantly less than that on plots sprayed with the other fungicides. Colloidal copper and Cobredon at 6 oz./acre gave equal protection. Flit and Fitox at 8 oz. afforded less control than the former two. Also in this instance the lower dosages led to a higher blister blight infestation than the normal rates.

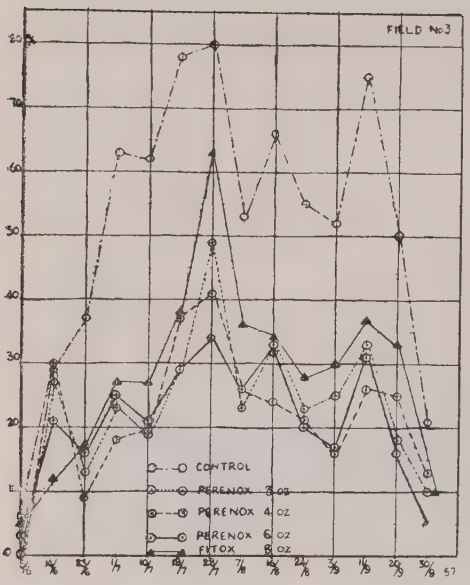
Where the yield is concerned, it appeared that only the plots sprayed with Colloidal copper at 3 oz. gave a significantly higher yield than the unprotected plots. The plots treated with the other fungicides also yielded more than the control but the differences were not statistically significant, probably due to the fact that spraying was started rather late.

II. The graphs (figure 2) have been presented in order to illustrate more clearly the blister blight incidence during the monsoon and the effect of the different rates of fungicides on infestation. It is worthy of note that the blister blight pattern for the period concerned is about the same for all three fields. A negligible infestation until the middle of June, even in the unprotected plots, was followed by a heavy outbreak of blister blight by the end of July. The level of infestation after that fluctuates with a smaller peak in the middle of September. By the beginning of October blister blight incidence had dropped to very low levels in all fields.

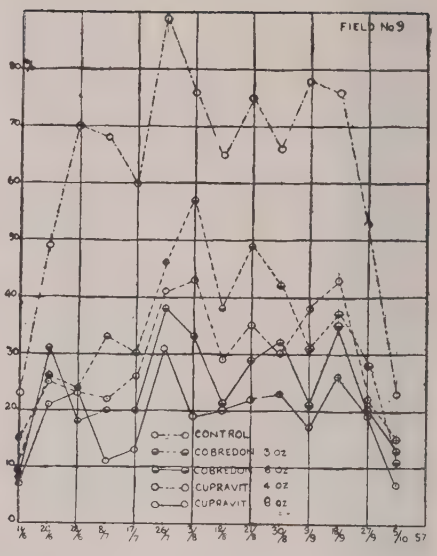
Field No. 3, (see figure 2A). The graph concerning this field shows that the three levels of Perenox (3, 4 and 6 oz) were almost equally effective with one exception, *viz.* on 28th July, when blister blight infection reached its peak. The protection given at that date was more or less determined by the absolute amounts of copper applied, Fitox (12% Cu) giving the least protection at that time. The latter fungicide at 8 oz. (1 oz. Cu) was throughout the experiment even less effective than Perenox at 3 oz. (1.5 oz. Cu).

Field No. 9, (see figure 2B). The graph of this field demonstrates that spraying at the lower levels of Cobredon (3 oz.) and Cupravit (4 oz.) led to an increased infection in comparison with the normal dosages (6 and 8 oz.) throughout the monsoon. Cobredon being less protective than Cupravit.

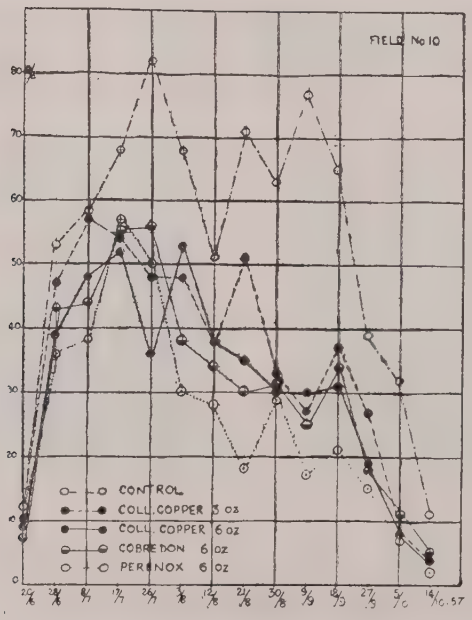
Field No. 10, (see figure 2C). The graph referring to this field has been included to show what happens if fields are not adequately protected before the visible outbreak of blister blight at the start of the monsoon. Namely, while the other fields were protected from the middle of May, the spraying of Field No. 10 only commenced from the 21st of June. Although all the fields showed very little



A



B



C

Figure 2. A.B.C. Blister infection in percentages throughout the S. W. monsoon after spraying with different fungicides at different rates.

or no infection until the middle of June, the subsequent infection of the previously unprotected field is about twice as high (for plots sprayed at the rate of 6 oz.) as that of similar plots in the other fields which were sprayed in time. Moreover, it took a much longer time before the fungicidal applications could bring down the blister blight infestation to a reasonably low level.

In the beginning there is little to choose between any of the fungicides, but later on Perenox at 6 oz. gives somewhat better protection than colloidal copper or Cobredon at 6 oz./acre.

4. Yield and blister blight in relation to fungicidal application rate

The data in table 1 are presented as a summary of the general effect of the lowering of the application rate on the yield and blister blight incidence in the field. The table also contains the data concerning the treatments in which the normal rate was halved after the 10th round (H/L).

Table 1. *Blister blight infection and yield after spraying with several fungicides at different levels in different fields.*

Field No.	Formulation and Copper content in %	Rates in oz./acre			% Infection			Yield in lb. made tea*		
		L.	H/L.	H.	L.	H/L.	H.	L.	H/L.	H.
9	Carbonate —45%: Cobredon	3	6/3	6	33.0	22.0	24.7	72.0	65.7	77.9
3	Oxide —50%: Perenox	3	6/3	6	23.0	21.2	21.2	100.1	84.2	96.7
3	Oxide —50%: Copper Sandoz	3	6/3	6	21.9	18.1	21.0	100.9	90.4	95.0
8	Oxide —70%: Red Copper	4	6/3	6	21.4	18.2	19.3	80.8	79.0	85.5
3	Oxychloride —50%: Shell Copper	4	6/3	6	20.4	19.0	19.0	89.7	95.3	97.2
9	Oxychloride —35%: Cupravit	4	—	8	29.0	—	18.5	77.2	—	64.1
10	Colloidal —26%: Duphar	3	6/3	6	38.0	37.3	33.5	97.2	97.4	95.2
	Average				26.9	22.8	22.4	88.3	85.2	87.4

*Yield per 1,200 bushes for 14 plucks

With respect to blister blight infection, the table shows that the reduction of the initial rate of fungicide to half after the 10th round (H/L) did not increase the average blister blight incidence as compared with that of plots protected at the normal rate (H) throughout. However, it must be remarked that the application rate was reduced only after the conditions for blister blight became less favourable.

Even the protection afforded by 3 oz. or 4 oz. (L) was on the whole satisfactory and on average not much less than that given by 6 oz. or 8 oz. per acre, presumably on account of blister blight infestation being only moderately severe during this monsoon. However, where the individual fungicides are concerned, it was quite apparent from the foregoing that the protection given at times of heavy infestation largely depends on the amount of *metallic* copper applied/acre (see comments on Field No. 3, figure 1A and 2A).

With respect to yields, these fluctuate for the different fungicides sometimes notably with application rate, probably mainly due to variability in the field. On an average the yields are practically the same for all application rates. Nevertheless, during severe outbreaks of blister blight a reduction in the amount of copper applied is likely to lead to loss of crop, as is illustrated by table 2.

The data in this table relate to blister blight infection and loss of crop occurring at the peak of blister blight attack and in the round following this attack. As Perenox (6 oz.) and Fitox (8 oz.) were both represented in three fields (No. 3, 8 and 10), the yields in the plots protected with these fungicides were chosen for comparison with the controls.

Table 2. *Blister blight incidence and yield recorded at peak of blister attack and in the subsequent round; averaged for three fields.*

Treatments	At peak of attack			Round following peak		
	% Inf.	Yield*		% Inf.	Yield*	
		Lb.	%		Lb.	%
Unprotected	85	5.44	65.3	56	4.74	63.8
8 oz. Fitox (12% Cu)	67	8.13	98.8	39	6.41	86.3
6 oz. Perenox (50% Cu)	37	8.33	100.0	23	7.43	100.0

*Yield in lb. made tea/1,200 bushes per pluck.

It follows from the above table that losses in crop during heavy blister infestation can be very considerable, amounting in this case to 35 per cent. It can be also seen that yield losses due to lack of control became more noticeable in the round following the heavy outbreak of blister blight. At the time that the heaviest infection was recorded Fitox and Perenox sprayed plots yielded practically the same, while in the round following, the former yielded 14 per cent less than the latter.

The following table gives an idea of the loss of crop incurred over the entire period that yield was recorded (14 plucks).

Table 3. *Average blister blight incidence and total yield recorded during the South West monsoon on unprotected and protected plots in three field experiments.*

TREATMENTS	% Infection in field No.			Average	Yield in *Field No.			Average	
	3	8	10		3	8	10	Lb.	%
Unprotected	52.0	57.1	54.4	54.5	77.9	62.3	85.1	73.8	83.6
8 oz. Fitox (12-16% Cu)	28.0	33.4	38.2	33.2	95.3	75.9	94.7	88.6	100.3
6 oz. Perenox (50% Cu)	21.2	18.3	27.5	22.3	96.7	73.9	94.4	88.3	100.0

*Yield in lb. made tea/1,200 bushes for 14 plucks.

It appears from table 3 that the unprotected plots showed much greater infestation, while the loss of crop averaged about 16 per cent in comparison with the plots protected by Fitox or Perenox.

This loss in crop is not excessive probably partly due to the fact that the blister infestation was moderately severe and partly due to the fact that the bushes were already full grown so that little "capital" damage was incurred. Moreover, the unprotected plots were surrounded by protected areas which possibly might have reduced infestation. It is worthy of note that plots sprayed with Fitox yielded as much as those sprayed with Perenox, though the former showed considerably more infestation than the latter.

5. Discussion and conclusions

I. With regard to the *effectivity of fungicides* tried out it appeared that there was little to choose between the 50 per cent (Perenox and Copper Sandoz) and 70 per cent (Red Copper) cuprous oxides as they gave equally satisfactory protection. Contrary to earlier findings (3), we found that Red Copper at 6 oz. compared favourably with Perenox at the same rate.

The experiments also showed that the 35 per cent (Cupravit blue) and 50 per cent (Shell Copper) oxy-chlorides showed control comparable to that of the standard fungicide (Perenox) thereby confirming previous findings in Ceylon (13) and in India (10) that copper oxides and oxy-chlorides are equally efficient.

Under the conditions of these trials, the addition of a special sticker in the case of Shell Copper, did not appear to have much effect in comparison with other 50 per cent fungicides without a sticker and at the same rate.

The 45 per cent copper carbonate (Cobredon) applied at 6 oz. was again proved (see also **3**) to give protection as effective or nearly as effective as Perenox. The same held true for the 26 per cent colloidal copper (Duphar) at 6 oz. which gave protection as good as Cobredon, and only slightly less control than Perenox notwithstanding its much lower copper content. The suitability of colloidal formulations, having a comparatively low copper content was also previously shown at St. Coombs (**14**) and in experiments carried out in India (**10, 16**) and Indonesia (**17**).

Contrary to the conclusions drawn from the 1956 trials (**4**), the 12 per cent coated powder preparation (Fitox), changed to a 16 per cent copper formulation in the latter half of the monsoon, appeared to provide unsatisfactory control at 8 oz., the protection given being markedly less than that afforded by the above mentioned fungicides at 6 oz. None of the three organic fungicides—Phthalic 4444a, Flit 406 and E.F.250—gave satisfactory protection at 8 oz. when compared with a 50 per cent cuprous oxide at 6 oz./acre. Compound 4444a and Flit were also found in trials in India to be less efficient at 8 and 6 oz. per 10 gallons of water respectively (**10**).

Bordeaux mixture at 8 oz. (2 oz. Cu) gave protection equivalent to that of 4 oz. of the 50 per cent fungicides (2 oz. Cu).

II. With respect to *reduced levels of fungicide*, it was found that the copper oxides, oxychlorides, carbonate and the colloidal copper were able to give a reasonable protection of fields in plucking at 3 oz. or 4 oz./acre under moderately severe monsoonal conditions. This confirms the conclusions drawn from the 1956 trials (**4**). However, it must be noted that the protection given during periods of severe infestation is more or less proportional to the amount of metallic copper given. Therefore, spraying at half the normal rate is not recommended at places where conditions for blister blight are favourable or during severe monsoonal weather. Neither is a rate lower than 6 oz./acre/round to be recommended for tea which is being brought into plucking, because this might easily lead to unsatisfactory control as was found in India (**5**) with Perenox applied at 3.4 oz./acre.

It is doubtful whether the reduction of the normal rate to half, only after 10 rounds of normal spraying, is any less risky, as one has no guarantee that subsequent monsoonal weather will be less favourable for infestation. It certainly pays to start spraying early at the normal rate before the monsoon sets in, because if timely protection is not given, it might take as much as 6 rounds of spraying before the level of infection falls within reasonable limits.

It is easier, and cheaper, to keep the field free from blister blight than to free it from blister after the field has become severely infested.

III. It appeared from the *crop returns of the sprayed plots* that the total yield over the period varied insignificantly in most instances, irrespective of the fungicide used or its rate of application. The loss of crop incurred on unprotected plots amounted to about 16 per cent over 14 rounds. This loss is not great probably because the blister blight infestation was only moderate during most of the period concerned. Much greater losses would have been experienced if the infestation had been more severe as can be derived from the fact that loss in crop during two rounds at the peak of blister blight attack was 35 per cent.

It should also be noted that damage to foliage sustained during the monsoon will have its after-effects subsequently. From previous reports (**2, 3, 15**) the yearly

losses over the cycle can be safely estimated to be between 20 and 25 per cent in unprotected areas as compared with adequately protected fields.

In connection with blister incidence and yield it is worthy of note that the returns of the Fitox protected plots were equal to those of the Perenox protected plots, notwithstanding the fact that the former showed markedly more infection than the latter, *viz.* 33 per cent versus 22 per cent. It is not impossible that this might be explained on account of the fact that the better protection given by the three times higher amount of copper in the case of Perenox (3 oz. Cu versus 1 oz. Cu/acre) was counter-balanced by a decrease in crop due to phytotoxic effects of the copper applied. Unfortunately no data are available on the phytotoxicity of copper* in tea as yet, so that it cannot be said with any certainty whether observed differences in crop with some other fungicides are due to chance or to a greater or lesser toxicity of the preparations concerned.

On the other hand, the explanation might be sought in the fact that the mean level of infestation on the plots sprayed with Fitox was still not so high as to cause a noticeable decrease in crop. This would seem to fit in with the arbitrarily chosen level of "35 per cent infection" below which it is assumed that satisfactory protection is achieved (**18**).

IV. With regard to the *economics of spraying*, the profit derived from spraying every round at 6 oz. in terms of an increase in crop appears to be fairly small during a moderately severe monsoon. For instance, it was found that under experimental conditions at St. Coombs the gain in crop of fields protected at 6 oz./acre amounted to 45 lb. made tea/acre over 17 plucks (half May to beginning October). The costs of spraying 17 rounds amounted to Rs. 42.16 (on a basis of estate costs of Rs. 2.48/acre/round).

Admittedly this rough approximation of costs and profits does not take into account the subsequent loss in crop which is likely to be sustained in unprotected fields even after the monsoon has abated.

Nevertheless, it serves as an illustration that a saving on spraying costs is an important matter. One way to economize would be to reduce the normal rate of 6 oz./acre to half that amount. However, by doing so one would bring down costs only by about 11 per cent, as normally the cost of fungicides at 6 oz./acre amount to approximately 25 per cent of the total costs (**11**). Much more money could be saved by a reduction of the number of rounds. For example, if a number of 15 spraying rounds carried out during the South West monsoon could be reduced to 12 rounds, while maintaining the 6 oz./acre/round rate, the cost would have been reduced by 20 per cent.

That such a possibility theoretically exists is clear from the graphs illustrating the pattern of blister incidence during the monsoon of 1957. One would have been able to postpone the spraying on several occasions, if only one had been able to forecast the severity of infestation. However, without a reliable forecasting method, reducing the application rate, or postponement of spraying involves a serious risk.

Investigations by HOMBURG (**8**) and HUYSMAN (**9**) and recently by DE WEILLE (**6, 7**) in Indonesia on the effect of macroclimatological factors on blister blight incidence have provided a basis for a forecasting system. The last investigator has shown that sunshine was the deciding factor in preventing blister blight infection. According to him, forecasts based on sunshine records have given satisfactory results up till now.

With respect to the above it is the opinion of the writers that further research on the economic control of blister blight should lie in the direction of a practical method of forecasting blister blight infestation.

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* See VISSER, T. et al: A note on the effect of different copper preparations on tea yield. Tea Quart. **29** (1), 1958.

6. Summary

A number of 12 fungicides were tried out on tea in plucking at St. Coombs during the South West monsoon of 1957 at rates varying between 3 oz. and 8 oz. per acre per round.

It was found that formulations of copper-oxides and oxy-chlorides of varying copper content as well as colloidal copper and copper-carbonate gave efficient control at 6 oz. or 8 oz./acre. Also spraying of these fungicides at 3 oz. or 4 oz. per acre throughout a moderately severe monsoon afforded satisfactory protection in most instances (on tea in plucking). The coated dispersible powder formulation containing 12 per cent (16%) copper and also three organic fungicides applied at 8 oz. were significantly less efficient than the standard 50 per cent cuprous oxide at 6 oz./acre.

Bordeaux mixture at 8 oz. gave protection in measure with its copper content, equivalent to 4 oz. of a 50 per cent copper fungicide.

The total yields of the sprayed plots over the period concerned varied only insignificantly in most cases, irrespective of the fungicides applied or their rate of application.

The loss in crop on the unprotected plots averaged 16 per cent over the monsoonal period in comparison with adequately protected areas.

The advantage of a practical system for forecasting the severity of blister blight infestation was discussed with regard to reducing the costs of spraying without serious risks.

Acknowledgments

The writers are indebted to the former Pathologist, Mr. B. N. Webster, who initiated three of the trials on blister blight control and to those firms which have given assistance in carrying out the experiments.

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THE VALIDITY OF ASSESSING TEA YIELDS ON A BASIS OF INTERMITTENT PLUCKING AND TEST PLUCKING

T. Visser

1. Introduction

The effect of manuring, cultivation, method of plucking, etc. on the yield of tea often cannot be ascertained by observations over a short period. Consequently, in many instances long term experiments are necessary.

As tea is plucked every 7-9 days, it needs little imagination to realise that the labour involved in plucking and recording the individual yields of the experimental plots is very considerable. This is the more so, when the recorded fresh weights are converted into dry matter, as has been customary at the Tea Research Institute.

In the opinion EDEN (1931), expressing the yields as dry matter is a necessary procedure, because "the incidence of rain during the 24 hours of a day is such that even over a period there can be no balancing out of these effects." According to the same author, experiments might be conducted by means of sample plucking instead of recording every pluck. EDEN compared the total yields (over 42 plucks) with the yields of every *third* round (over 14 plucks) and found a very high and significant correlation between occasional and total pluckings in an uniformity trial. He concluded that the plucking of every third round "gives results which allow valid comparisons without an appreciable loss in accuracy."

The above conclusion was written in 1931, but for unknown reasons this practice was not, or rarely, adopted by the Tea Research Institute. The present author, therefore, has again tested the validity of calculating the total yield of field experiments on intermittent plucking. The validity of basing yields on fresh weight instead of dry weight records was also investigated.

The second part of the paper deals with the question whether for purposes of final selection also the yield of clones can be assessed by intermittent plucking. It was further investigated whether or not "test plucking"—the yield of a number of consecutive plucks over a limited period—could serve for the selection of such clones planted in multiplication plots. The validity of test-plucking has been previously studied *e.g.* by COHEN STUART and WELLENSIEK for large scale mother bush selections. Test plucking has been often used in Indonesia since then for the comparison of yields of mother bushes and in field experiments, and it was also employed at the Tea Research Institute for the initial valuation of the mother bushes in the field. Also EDEN (1941) investigated this method with regard to the number of flush shoot counts required for a reliable estimation of yield of mother bushes.

The usefulness of a quicker and less time-consuming selection is apparent, as so far the selection of clones represented by a limited number of bushes has taken one or more pruning cycles involving the recording of the yields of each clone at each round.

2. Intermittent plucking of field experiments

2.1. Methods and material

Of each of the field experiments the weighings—or mean of the weighings, in cases where the experiment was replicated—of 90 plucking rounds of the last

completed pruning cycle were taken for calculation. The "actual yield" (total of 90 plucks) was compared with the "calculated yields" based on every 2nd (45 plucks), 3rd (30 plucks), 5th (18 plucks) and 7th (13 plucks) plucks respectively. That is to say, the total calculated yields were obtained by multiplying the individual yields of every 2nd, 3rd, 5th and 7th plucks by 2, 3 5, and 7 respectively, and adding the figures thus obtained.

The "paired-difference" method was adopted in order to ascertain whether or not the differences occurring between *actual* and *calculated* yields were significant. The same method was applied to demonstrate the significance of differences between yields of *different treatments* when based on intermittent plucks. In certain instances also the Chi-square test was applied in order to ascertain the association between actual and calculated yields.

The data of two treatments each of three long term field experiments—situated in different fields of the estate—were chosen for statistical comparison of actual and calculated yields. The manurial treatments in each of the different experiments were the same, *viz;* manuring with a single dose of nitrogen (S N = 40 lb.N/acre) as compared with a double dose of nitrogen (D N = 80 lb. N/acre). Both treatments received the same basic application of P and K.

2.2. **Results**

As the data regarding the relation between actual and calculated yield were qualitatively the same for all three field experiments, only those for the "cultivation experiment" are given in table 1 (average for 6 replicates each of 1/24th acre). Table 2 presents the Chi-squares for the actual and calculated yields of the same experiment.

Table 1. *The relation between actual and calculated yields based on intermittent plucking.*

1	2	3	4	5	6	7	8	9	10	11
Yields based on	Fresh weight lb. per 1/24th acre			Dry weight lb. per 1/24th acre			Correlation with all plucks			
							Fresh Weight		Dry Weight	
	D N	S N	Difference	D N	S N	Difference	D N	S N	D N	S N
All plucks (n = 90)	467	367	100 (27) ***	101	82	19 (23)***	—	—	—	—
1 in 2 plucks (n = 45)	457	367	90 (25) ***	100	80	20 (25)***	0.889	0.909	0.912	0.907
1 in 3 plucks (n = 30)	463	362	100 (28) ***	100	82	18 (22)***	0.865	0.861	0.861	0.983
1 in 5 plucks (n = 18)	450	364	86 (24) ***	98	80	18 (23)***	0.864	0.924	0.882	0.915
1 in 7 plucks (n = 13)	† 398	† 331	61 (20) **	† 87	† 73	14 (19)***	0.910	0.912	0.905	0.920

N.B. (*a*) The figures between brackets in columns 4 and 7 give the mean difference in percentages between plots manured with double nitrogen (= D N); and single nitrogen (= S N);

(*b*) Differences between *actual yield* (all plucks) and *calculated* yield significant for: † P = 0.05;

(*c*) Difference between *treatments* significant for: *) $P = 0.05$; **) $P = 0.01$; ***) $P = 0.001$;

(*d*) All correlations are positive.

Table 2. *Association of actual and calculated yields as shown by the Chi-square test.*

Yields based on	For fresh weights		For dry weights	
	S N	D N	S N	D N
1 in 2 plucks	12.12:P> 0.99	14.03:P> 0.99	2.20:P> 0.99	2.61:P> 0.99
1 in 3 plucks	17.02:P> 0.95 <0.99	20.91:P> 0.80 <0.90	3.47:P> 0.99	3.28:P> 0.99
1 in 5 plucks	8.25:P> 0.95 <0.99	14.48:P> 0.50 <0.70	1.59:P> 0.99	2.41:P> 0.99
1 in 7 plucks	15.73:P> 0.20 <0.50	26.81:P> 0.01	3.18:P> 0.95	5.39:P> 0.80 <0.95

N.B. S N = single dose nitrogen; D N = double dose nitrogen.

The following can be derived from tables 1 and 2:

(*a*) The correlation coefficients for actual and calculated yields are all high and significant, both for fresh weights (columns 8, 9) and dry weights (columns 10, 11). However, the Chi-squares (table 2) for the yields based on fresh weights are much higher than those for yields based on dry weights, indicating the greater variability of the former yields.

(*b*) Fresh weight yields (columns 2, 3) and dry weight yields (columns 5, 6) based on 1 in 2, 1 in 3 and 1 in 5 plucks deviate insignificantly from the actual yield, they are also adequately associated with it. Yields calculated from every 7th pluck deviate significantly from the actual yield, and for the fresh weight yield also the association is inadequate.

(*c*) The differences between treatments (double versus single nitrogen) for actual and calculated yields are significant in all instances, both for fresh and dry weight yields (columns 4,7).

The above observations are qualitatively the same for all three field experiments. It must be added that the significance of the differences becomes less as the number of plucking rounds from which the yield is calculated decreases, slightly more so for fresh weight than for dry weight yields. The margin between significance and non-significance for yields based on 1 in 7 plucks is often narrow, so that it will be safer to base the yields on 1 in 5 plucks, or better still on 1 in 3 plucks.

3. **Fresh weight as a basis for yield determination**

A great deal of time and labour would be saved if yields could not only be based on intermittent pluckings, but also if fresh weights instead of dry weights could be used for an accurate assessment of yield.

EDEN assumed that this cannot be done as moisture adhering to the leaves would increase the variation between individual pluckings to an impermissible extent. However, it seems more likely to the present author that the weighings of different plots of a field experiment over one or more years (40 plucks per year) will contain on average the same amount of moisture. Namely, it may be presumed that over such a period all plucks will be on average an equal number of times dry or wet. Consequently, the differences between treatments will remain approximately the same, irrespective of rain. This supposition is borne out by the fact

that the differences between *treatments*, expressed in percentages, were of the same order in all three field experiments, irrespective of whether dry or fresh weight yields were compared.

The same can be derived from the fact that the average moisture contents—averaged over 100 consecutive plucks—of samples collected from 27 different manurial treatments respectively were found to be practically the same.

Table 3. *Correlation between fresh weight and dry weight of actual and calculated yield.*

Treatments	r for actual fresh and dry yields	r for calculated fresh and dry yields			
		1 in 2 plucks	1 in 3 plucks	1 in 5 plucks	1 in 7 plucks
Manurial Single N	0.983	0.987	0.988	0.988	0.857
experiment Double N	0.984	0.986	0.987	0.99	0.984
Plucking Single N	0.965	0.940	0.954	0.981	0.903
experiment Double N	0.962	0.950	0.942	0.978	0.839
Cultivation Single N	0.978	0.901	0.896	9.970	0.993
experiment Double N	0.967	0.987	0.926	0.960	0.982
Average for 3 experiments	0.976	0.957	0.971	0.986	0.956

N.B.—All correlation coefficients are positive.

Further evidence that both actual yields and yields based on intermittent plucking can be determined on a fresh weight basis, is furnished by table 3. This table shows that the correlations between dry and fresh weight yield are high and significant both for actual and calculated yields in all instances.

4. Intermittent plucking and test plucking of clones

4.1. Methods and material

The data below concern clones which were planted in "multiplication" plots in rows of 10-12 bushes per clone. The yields of these clones were recorded on a basis of fresh weights. The validity of yield assessment based on "intermittent" or "test" plucking was ascertained as follows:

(*a*) Firstly, the actual yield of 90 plucking rounds was compared with calculated yields based on every 2nd, 3rd, 5th or 7th pluck. (See page 21). These calculations were carried out on three clones using the data of the 1st pruning cycle; they belonged to the "main clonal area."

(*b*) Secondly, it was determined how many consecutive plucks were required, once the clones came into plucking, for a reliable selection of the highest yielders among them. For this purpose 32 clones belonging to the "1947 area" were chosen. Starting with the 6th pluck, the correlation coefficients were calculated for the yield of 1 pluck only (6th pluck), 2 consecutive plucks (6th + 7th pluck) . . . . and 11 consecutive plucks (6 + 7 + ... 16th pluck) respectively with the yield over the 1st year (40 plucks) and over the pruning cycle (120 plucks) respectively.

(*c*) Thirdly, it was investigated how soon after coming into bearing, the yield based on 10 consecutive plucks could serve to point out the highest yielders among a number of clones. In this case yield data of the first cycle of 22 clones belonging to the "1947 blister resistant area" were used. It was calculated what correlation existed between yields of each series of 10 consecutive plucks (1st-10th, 11th-20th, ..., 111th-120th respectively) and the total cycle yield (120 plucks).

4.2. **Results of intermittent plucking**

The data concerning the actual and calculated yield of 3 clones are presented in table 4; those with regard to the Chi-square test on one clone are given in table 5.

Table 4. *Relation between actual yield and calculated yield based on intermittent plucks (in oz. per 11 bushes); observations carried out on clonal tea.*

		CALCULATED YIELD BASED ON				
		All plucks (n = 90)	1 in 2 plucks (n = 45)	1 in 3 plucks (n = 30)	1 in 5 plucks (n = 18)	1 in 7 plucks (n = 13)
Clone 777	(Fresh weight	1,167	1,187	1,256	1,164	1,050
	(Correlation	—	+ 0.938	+ 0.901	+ 0.812	+ 0.773
Clone 1	(Fresh weight	1,098	1,164	1,059	1,093	1,324
	(Correlation	—	+ 0.905	+ 0.922	+ 0.774	+ 0.898
Clone 1294	(Fresh weight	540	529	557	503	664
	(Correlation	—	+ 0.918	+ 0.904	+ 0.659	+ 0.750
Average yield in %		100	102	102	97	111
Difference clone 777-1294		627***	658***	699***	661***	386*
As % of yield of clone 1294		116	125	126	132	58

N.B. For *), **), ***see table 1.

Table 5. *Association between actual and calculated fresh weight of clone 1294 as shown by the Chi-square test.*

Chi-square for actual yield with calculated yield	Chi-square	P
1 in 2 plucks	25.14	$P > 0.80 < 0.90$
1 in 3 plucks	28.73	$P > 0.30 < 0.50$
1 in 5 plucks	77.11	$P < 0.01$
1 in 7 plucks	142.4	$P < 0.01$

It follows from table 4 that the correlations between actual and calculated yield are significant in all instances. However, those between actual yield and the yield based on every 5th or 7th pluck are considerably lower than for the yield calculated from 1 in 2 or 1 in 3 plucks. The variability of yields, based on each 3rd, 5th and 7th pluck, is also demonstrated by the fact that the association with the actual yield is not adequate (Table 5). Nevertheless, none of the differences between actual and calculated yields is significant due to the high standard erors caused by the variability in yield from pluck to pluck.

The difference between the yields of clone 777 and 1294 is great and therefore significant, even if the yields are based on 1 in 7 plucks. However, in the latter case, the calculated difference—reduced to half of the actual difference—is only reliable on the 5 per cent probability level.

It is clear from the Chi-squares given in table 5 that the calculated yields of clones were less representative for the actual yield than was the case in field experiments (table 2) on account of the fact that the former yields were based on 10-12 bushes and the latter on about 700 bushes. The differences between clones also have to be relatively greater as they may display different growth performances from period to period. That is to say, a certain clone may produce a significantly greater yield than another over the first year of the cycle, whereas the roles may be reversed in the following year. Therefore, if fresh yields of clones represented by a limited number of bushes are to be calculated on intermittent plucks, it will be advisable to base the yield on not less than 1 in 2 plucks.

4.3. **Results of test plucking**

I. The correlation of the yields of consecutive plucks (starting with the 6th pluck after bushes came into bearing) with cycle yield (120 plucks) and the yield over the 1st year (40 plucks) for 32 clones are given in table 6. This table also includes the correlations determined by WELLENSIEK for the yields of an increasing number of consecutive plucks (starting with the 17th pluck) with the yield of 48 plucks for 1555 individual bushes. Also presented are the correlations found by COHEN STUART for the yields of consecutive plucks (starting with the 22nd pluck) with the yield of 42 plucks for about 200 mother bushes.

Table 6. *The correlation of the yields of a limited number of consecutive plucks with the cumulative yield over about one year or longer.*

1	2	3	4
Correlation of yield of **120** plucks with:	Correlation of yield of **40** plucks with:	Correlation of* yield of **48** plucks with:	Correlation of** yield of **42** plucks with:
1 pluck + 0.335	1 pluck + 0.405	1 pluck + 0.396	1 pluck + 0.473
2 plucks + 0.728	2 plucks + 0.783	2 plucks + 0.746	2 plucks + 0.370
3 plucks + 0.658	3 plucks + 0.734	3 plucks + 0.816	3 plucks + 0.688
4 plucks + 0.674	4 plucks + 0.745	4 plucks + 0.898	4 plucks + 0.796
5 plucks + 0.859	5 plucks + 0.923	5 plucks + 0.930	5 plucks + 0.824
6 plucks + 0.891	6 plucks + 0.961	6 plucks + 0.929	6 plucks + 0.858
7 plucks + 0.807	7 plucks + 0.880	7 plucks + 0.926	7 plucks + 0.834
8 plucks + 0.889	8 plucks + 0.973	8 plucks + 0.860	8 plucks + 0.802
9 plucks + 0.866	9 plucks + 0.958	9 plucks + 0.771	
10 plucks + 0.867	10 plucks + 0.954	10 plucks + 0.952	
11 plucks + 0.876	11 plucks + 0.963	11 plucks + 0.949	

*) Figures from WELLENSIEK **) Figures from COHEN STUART

Table 6 shows that COHEN STUART's, WELLENSIEK's and our figures are very similar. The correlations for the yield of 5 consecutive plucks with the yield of about one year (the first year after the bushes came into bearing for the first time) are already very high and significant (columns 2, 3, 4). It can be observed that a drop in the correlation coefficient occurs for yields based on 7 (column 2), 8 (column 4) or 9 (column 3) consecutive plucks. Correlations for yield based on 1 or 2 plucks more are again higher. Presumably this is not a chance occurrence as such a decline occurs in all three sets of figures. Accordingly, if test plucking is to be carried out, it would seem safer to base it on not less than 10 consecutive plucks.

The correlations of 1, 2 . . . . 11 plucks with the cycle yield (column 1) are all lower than the equivalent coefficients with the yield of the first year (column 2). This indicates that test plucking done just after the bushes come into bearing for the first time is not entirely representative for the potential yield of the clones for the whole cycle.

As an illustration of what the correlations would have meant in practice the following can be remarked:

The yield of as few as 5 consecutive plucks would have sufficed to point out the 3 highest yielding clones, *viz.* respectively 149%, 75% and 75% higher than the average cycle yield for all 32 clones. The next best (77% above average) would have been found on a basis of 10 consecutive plucks. However, not even the cumulative yield of 40 plucks (1st year) would have been sufficient to detect the two subsequent highest yielders (50 and 36% above average). Instead, this yield would have indicated as the next best, two clones which yielded only about 10% above average. In order to detect the former two (50 and 36% above average) either test plucking in the *second* year, or total cycle yields would have been required.

II. In the following table the correlations are given for the yields of each 10 consecutive plucks (1-10th, 11th-20th, etc.) with the cycle yield (for 22 clones), starting from the moment the bushes came into plucking for the first time.

Table 7. *Correlation coefficients for the cumulative yields of each consecutive ten plucks with the cycle yield in relation to the time after the clones came into bearing.*

1st year	1 — 10th	11 — 20th	21 — 30th	31 — 40th
	+ 0.878	+ 0.907	+ 0.927	+ 0.958
2nd year	41 — 50th	51 — 60th	61 — 70th	71 — 80th
	+ 0.949	+ 0.949	+ 0.977	+ 0.963
3rd year	81 — 90th	91 — 100th	101 — 110th	111 — 120th
	+ 0.944	+ 0.941	+ 0.962	+ 0.951

It can be observed from table 7 that all correlations with the cycle yield are high, those for the yields of the first three series of 10 plucks being lower than those for subsequent test plucks. Apparently, test plucks done in the first year are less representative for the yield of the clones than those done in the second year after the bushes came into bearing. The correlations for the third year are somewhat lower than those for the second year.

The practical meaning of the correlation coefficients can be illustrated as follows:—

If on account of the yield for the *first* 10 plucks the four highest yielders had been chosen, one would have found that according to the cycle yield only the best clone (134% above average) was among the four. The other 3 clones would have been comparatively inferior, with cycle yields not much higher than the average cycle yield for all 22 clones. However, among the four highest yielders chosen on a basis of the yields for the *second* series of 10 plucks, one would have found the 3 best clones (134, 92 and 74% above average) and only one relatively low yielding one (28% above average). Only test pluckings in the *second* year after coming into bearing would have ensured that the four highest yielders (134, 92, 74, 68% above

average) chosen on account of the yield of 10 consecutive plucks were also the four best ones on account of their cycle yield.

It appears from the above that in the one area the cumulative yield for the 6th to the 15th pluck in the cycle provided a basis for the selection of the 4 best from among 32 clones. In the other area the yield of the second series of 10 plucks in the cycle sufficed to detect the 3 best clones from a choice of four on a total of 22 clones. Similarly, EDEN (1941) showed that the three outstanding mother bushes, on a selected number of 10, could be found on the basis of the cumulative total of the first 16 consecutive flush counts.

It would seem, therefore, that the yield of the second series of 10 plucks after bushes come into bearing, would provide a good basis for the selection of the best 10 to 15 per cent of clones under trial in multiplication plots. In case one also wants to select the "next best" clones, either test plucking in the second year, or total cycle yields would be needed.

5. Summary and conclusions

Calculations were carried out in order to determine whether the work and time involved in assessing the yields of field experiments and clones could not be considerably lessened. To that purpose it was ascertained to what extent yields based on "intermittent plucking"—only every 2nd, 3rd, 5th or 7th pluck recorded—were representative for the absolute yields.

The same method was tested for the assessment of the yield of clones represented by a limited number of bushes. With regard to clones it was also investigated whether "test plucking"—the yield of a consecutive number of plucks—could serve as a reliable basis to estimate the potential yield of a clone early in its cycle.

The following observations and conclusions may be noted.

(1) With regard to field experiments, yields based on 1 in 2, 1 in 3, or 1 in 5 plucks did not significantly deviate from the absolute yields; those based on every 7th pluck often did. These findings are more or less true for yields of clones based on intermittent plucking, but the deviation from the absolute yield might be greater, as yields were based on about 12 bushes only.

(2) Noteworthy differences between yields of different treatments or clones remained significant when yields were based on intermittent plucking. However, the margin between significance and non-significance became narrower as the number of recorded rounds on which yields were calculated became less.

Yields of field experiments based on 1 in 3 plucks and yields of clones based on 1 in 2 plucks (over at least one year) can be expected to give as good a basis for comparison as yields based on all plucks.

(3) Fresh weight yields and dry weight yields were found to be highly correlated. It can be said that intermittent plucking based on fresh weights would provide a reliable basis for long-term yield determination.

(4) With regard to the test plucking of clones it was shown that the yields of 10 consecutive plucks are highly correlated with the cycle yield at each stage of the cycle, but less so during the first year than during the second year of the cycle. The data indicate that the yield for the second series of 10 plucks in the first year after the bushes come into bearing would suffice to choose the *best* clone out of every 10 clones under trial in the multiplication plot. Selection of the next best clones would be possible if the test plucks were carried out during the second year.

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OBSERVATIONS ON THE GERMINATION AND STORAGE OF TEA POLLEN AND SEED

T. Visser and L. M. de Waas Tillekeratne

1. Introduction

With a view to future breeding work which might be undertaken it seemed desirable to obtain some more information about the germination and storage properties of tea pollen and seed.

With regard to pollen, WELLENSIEK noted that it can be germinated in water, but little is further known about it. With respect to seed, studies have been made in the past regarding the thickness of the shell (GADD) and the effect of its removal on germination (TUBBS). In recent years some practical information has become available concerning the cold storage of seed (HUME, NOYES).

In order to add to the present knowledge a few experiments have been carried out on germination and conditions for storage.

2. Pollen germination and storage

The germination of the pollen was tested in different sucrose concentrations by means of the "hanging-drop" culture. It was found that 3 to 4 hours at room temperature (about 70°F.) sufficed to obtain maximal germination in any of the media tested. The average germination percentages (6 replicates) obtained in 0, 5, 10, 15, 20 and 25% sugar solutions were 83, 87, 87, 88, 83 and 75% respectively. These figures show that tea pollen germinates equally well in water as in sugar solutions up to 25%.

Pollen (including the stamens) collected from just opened flowers was subsequently stored in desiccators at a range of relative humidities. The latter were obtained with different concentrations of sulphuric acid. The desiccators were kept in a refrigerator at about 32°F. The viability of the pollen thus stored was tested at regular intervals by determining its germination percentage in 10% sugar solution (in triplicate). The results are presented in figure 1.

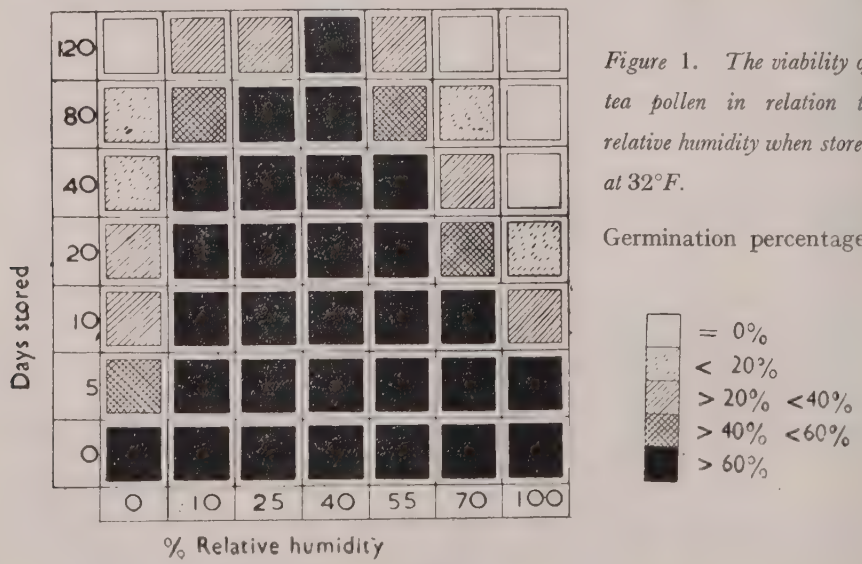

Figure 1. *The viability of tea pollen in relation to relative humidity when stored at* 32°*F.*

Germination percentage.

It appears from figure 1 that tea pollen can be optimally stored at 40% relative humidity; the germination percentage was still above 60% three months after storage. Unfortunately, the experiment had to be discontinued because of an accident with the desiccators. However, past experience suggests that the pollen might have been kept viable for some time longer, but not for a whole year. In order to prolong the longevity for one year or more, the pollen would have to be stored at deep freeze temperatures (VISSER).

3. **Seed germination**

It has been found with many seed species that removal of the seed coat or damaging it, accelerates the germination of the embryo. This might be due to the greater or lesser imperviousness of the seed coat for water and air, or its mechanical resistance (TUBBS, VISSER). As a complement to TUBB's studies it was further investigated what role the shell plays in germination with regard to the effect of pre-soaking of the seed and the cracking of the shell (by a light hammer blow).

I. In the first experiment seeds of which the shell was removed, cracked or left intact were "soaked" in water for 1, 2, 3, 5 and 7 days respectively, and subsequently germinated with the shell removed (embryo), cracked or intact. Accordingly, the tests were carried out with 6 groups of seeds:

a. Shell removed while soaked; germination with shell removed

b. ,, cracked ,, ,, ; ,, ,, ,, removed

c. ,, intact ,, ,, ; ,, ,, ,, removed

d. ,, cracked ,, ,, ; ,, ,, ,, cracked

e. ,, intact ,, ,, ; ,, ,, ,, cracked

f. ,, intact ,, ,, ; ,, ,, ,, intact

The seeds, were germinated in boxes with peat at room temperature. Progress of germination was checked at daily intervals; seeds showing a protruding radicle were taken as having germinated. The test was carried out with "fresh" seeds which had been kept in the room during a fortnight after collection in the tea seed garden. The results of soaking on water uptake by the seeds and subsequent germination are given in tables 1 and 2.

Table 1. *Relative weight of fresh seeds submerged in water for different periods expressed in % of weight of seeds* 13 *days in water; figures based on* 2×100 *seeds/treatment.*

	Days in water							
	0	1	2	3	5	7	10	13
Relative weight in %	71.0	81.0	87.4	91.6	96.5	99.0	99.7	100
% Sinkers	0	33	78	91	98	100	100	100

Table 2. *Number of days required to obtain 75% germination of "fresh" seeds submerged in water for different times and subsequently germinated with shell intact, cracked or removed; figures based on 2 × 50 seeds/treatment.*

1	2	3	4	5	6	7	8
Soaked with shell	Germination with shell	No. days needed for 75% germination after in water for					
		0 days	1 day	2 days	3 days	5 days	7 days
a. Removed	Removed	11.0	9.5	10.5	10.5	10.0	12.0
b. Cracked	Removed	11.0	11.0	9.5	9.0	9.0	12.5
c. Intact	Removed	11.0	10.5	9.5	9.0	8.0	7.5
d. Cracked	Cracked	36.5	36.0	29.5	27.0	26.0	36.5
e. Intact	Cracked	36.5	28.0	25.0	22.5	20.0	33.0
f. Intact	Intact	49.0	50.5	47.0	41.0	41.5	55.5

Table 1 shows that the seeds took up most of their water during the first 5-7 days of soaking, only a little more being taken up after that. That the seeds were nearly saturated at that time is also evident from the fact that all seeds had become "sinkers."

With regard to the influence of pre-soaking on germination it follows from table 2 that the quickest germination was obtained after 5 days of soaking. (column 7). Immersion for 7 days (column 8) seemed to have had an adverse effect, as germination of such seeds was considerably delayed as compared with the former, especially for cracked and intact seeds (*d*, *e*, *f*,). The removal or cracking of the seed shell prior to soaking gave slightly less results than soaking the seeds intact (compare *a* with *c*, *d* with *e*).

It is also apparent from table 2 that cracking of the shell and even more so its entire removal greatly accelerated the subsequent germination (compare *c*, *e*, *f*). It can be noted that the germination of the naked embryos (*a*, *b*, *e*) is little affected by pre-soaking. This is probably due to the fact that once the seed coat is removed, the rate of water uptake, respiration and mechanical resistance are no longer limiting factors.

These observations are confirmed by the experiment of Tubbs who found that the removal of the seed shell is accompanied by an increased water uptake and consumption of nitrogenous and fatty substances, indicating the increased physiological activity (respiration) of the embryo. Likewise, the favourable effect of cracking the shell beforehand can be attributed to a decreased mechanical resistance and increased respiration, as has also been shown to be the case in apple seed (Visser).

II A second experiment on the effect of soaking and subsequent cracking of the shells was carried out with seeds which had been stored for 3 months at room temperature (about 70°F) The intact seeds were soaked for 0, 2, 4, 6 and 9 days and then germinated intact, or with a cracked shell. In contrast with the former experiment the seeds were germinated out of doors in beds made up of river sand and covered by jute hessian.

Table 3. *The effect of soaking in water (seeds intact) and cracking of the seed shell on the germination of 3 months old seeds (100 seeds/treatment).*

1	2	3	4	5
No. days soaked	% Germination		Obtained after	
	30 days		50 days	
	Intact	Cracked	Intact	Cracked
0	33	37	52	57
2	28	32	46	38
4	42	46	49	46
6	50	39	53	41
9	31	14	33	15

N.B. *The germination recorded after 50 days is the final germination percentage reached; the other seeds had succumbed to rotting by that time.*

It appears from the results, presented in table 3, that pre-soaking up to 6 days appreciably accelerated the germination of the intact seeds (column 2), less so that of the cracked seeds (column 3). Soaking of the seeds for more than 6 days adversely affected the germination, particularly that of cracked seeds. It made little difference to the germination (after 30 days) whether the seeds were germinated intact or cracked (compare columns 2,3). From the assessment after 50 days it can be derived (columns 4, 5) that soaking has little effect on the final germination of the seeds unless they are soaked too long. The eventual germination of cracked seeds, except for the not soaked ones, is less than that of the intact seeds. This is probably due to the fact that a greater number of the former seeds rotted as the cracked shell afforded less protection against rotting organisms.

It appears from the two germination tests that the cracking of seed coats, had little or no effect on the "old" seeds (kept for 3 months), but greatly speeded up the germination of the "fresh" seeds (kept for 2 weeks) especially if they were also pre-soaked.

This difference in response is probably largely explainable on account of the different physiological conditions of the respective seeds. Pre-soaking and cracking of the seeds would sooner realise the condition required for the initiation of germination, such as the provision of the embryo with enough moisture and the lessening of mechanical hindrances. The vitality of the fresh seeds is such that the embryo can be presumed to react as soon as these conditions are fulfilled. The older seeds, however, have lost much of their vigour and their metabolism is accordingly retarded. Consequently, these embryos are not likely to profit from the enhanced water uptake and "air flow" by cracking the shell, as it would not be matched by an equivalent increase of physiological activity, hence the difference in response between old and fresh seed.

It can be remarked that tests with embryos (shell removed) enabled a quick assessment of the germination capacity of the seed, provided the seeds were comparatively "fresh". A prolonged storage of the seeds was found to increase the percentage of embryos which succumbed to rotting in the germination medium.

It is worthy of note that the shells can be easily cracked by putting the wet seeds in hot sunshine. It was found that between 50 and 95 per cent of the seed shells cracked if spread for only 15 minutes in the sun.

4. Seed storage

Freshly collected seed (2 weeks dry at room temperature) was stored in desiccators at the same relative humidities and temperature as used for the pollen. Twenty seeds were removed from storage at regular intervals and germinated at room temperature in peat. The seeds were soaked for 2 days and their shells cracked prior to the germination test.

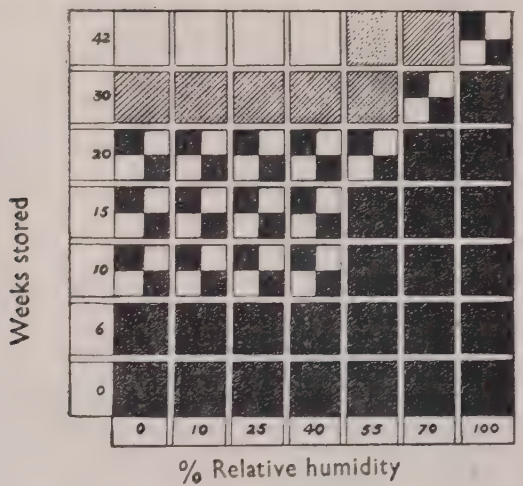

Figure 2. The viability of tea seed in relation to the relative humidity when stored at 32°F.

It can be derived from the results, as presented in figure 2, that the viability of the tea seeds was maintained better as the relative humidity was higher. This is rather unusual because the great majority of seed species optimally store at humidities between 10 and 50 per cent. The contrasting findings with tea seed are probably partly explained by the fact that storage of the seeds at lower humidities dries out the embryo to such an extent that it takes a long time before enough water is taken up to allow germination. During that time lag, the cracked seeds are liable to become rotten in the germination medium.

Our findings substantiate those of HUME and NOYES who stored seed in wooden boxes at 40°F. The former obtained more than 90 per cent, the latter nearly 70 per cent germination, 6 months after storage. It would, therefore, seem that no special precautions are needed for storage of seeds at temperatures just above freezing and under conditions which allow aeration. Naturally the seeds should be reasonably dry. On the other hand, if seeds are stored in sealed containers and/or below freezing point, it is necessary to dry the seeds thoroughly beforehand in order to prevent damage due to asphyxiation or freezing. It is likely that the failure of the seeds to germinate after storage in sealed tins at 20°F in HUME's experiment is due to the fact that the seeds were not sufficiently dry. Results with other seed species (WEIBULL) suggest that also tea seed might profitably be stored at deep freeze temperatures if not packed airtight and reasonably dry, or thoroughly dried if packed in sealed containers.

5. Summary and conclusions

Experiments were carried out with regard to the germination and storage of tea pollen and tea seed. The following observations were made:

1. Tea pollen germinated well both in water and in sugar solutions between 5 and 25 %.

2. Pollen stored at relative humidities between 0 and 100 % and at 32 F optimally maintained its viability at 40 % humidity. At this humidity the pollen still showed nearly 70% germination 3 months after storage. Storage at temperatures below freezing point is likely to maintain viability for longer than one year.

3. Pre-soaking of the seeds in water for 3 to 5 days and subsequent cracking or removal of their shell markedly speeded up the germination of comparatively fresh seeds. Older seeds were similarly affected by pre-soaking, but the cracking of the seed shell had little effect on the germination. Accordingly, if in practice an accelerated germination is desirable, pre-soaking and cracking of the seeds (in the sun after soaking) can be resorted to. Seed growers who want to evaluate quickly the germination capacity of freshly harvested seeds can do so by carrying out tests with seeds of which the shell is completely removed.

4. Seeds stored at the same humidities and temperature as the pollen appeared to give over 50 % germination 10 months after storage at 100 % relative humidity. Lower humidities gave less good results presumably due to subsequent infection by rotting organisms in the germination medium before the seeds are able to germinate. It is probable that storage at deep freeze temperatures would prolong the longevity of the seed if packed pre-dried.

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FACTORS AFFECTING THE PLANTING DISTANCE OF TEA

T. Visser and L. M. de Waas Tillekeratne

1. Introduction

Recent progress in replanting and new planting of tea with clonal material and on the contour system, focuses attention on an important point, namely spacing. A question frequently asked is what optimum spacing is required for a clone with regard to its vigour and spreading habit. It was thought, therefore, that it would be useful to review the information available from Indonesia, India and Ceylon on this subject.

In this connection also aspects which have an indirect bearing on spacing, *e.g.* those concerned with the growth of the individual bush in the field, will be reported.

2. Yield in relation to bush zones

The habit of the tea plant is to grow into a tree under natural conditions. It is, however, artificially modified by pruning to form a bush of height and width best suited for the purpose of plucking. It is a matter of practical interest, to know how such modification affects the growth of the bush in the field with respect to its centre and periphery.

Two experiments, one carried out by De Haan in Indonesia and one at the Tea Research Institute, regarding the growth pattern of the bush will be described below. Also the preliminary data concerning a "pre-prune" experiment will be presented. In the latter experiment it was investigated how yield was affected by removal of the "sides" of the bushes towards the end of their pruning cycle.

2.1 Zonal plucking: experimental

Investigations in both Indonesia and Ceylon were done on individual bushes. De Haan divided the plucking table of his bushes into a central and peripheral zone of equal surface with the help of concentric rings. In the experiment at St. Coombs the plucking tables of 5 clonal bushes were divided into 3 zones. The rings placed on the bushes at each plucking had a radius of 6″, 12″ and 18″ from the centre of the bush, dividing the bushes into circular areas, namely 0-6″, 6″-12″ and 12″-18″ from the centre. Accordingly, the inner zone occupied 1/9th, the intermediate zone 3/9ths and the outer zone 5/9ths of the bush surface.

The plucking system adopted in Indonesia and Ceylon was a bud + 2 leaves, leaving a foliage leaf above the fish leaf. Tender banji shoots were plucked, also leaving a leaf above the fish leaf. Flush and banji shoots were counted and weighed separately.

In the experiment at St. Coombs a further modification was introduced. Plucking, namely, was also done below the table in order to study the occurrence of the different crop shoots in each of the 3 zones *above*, *level with*, and *below* the normal plucking level respectively.

In De Haan's experiment records were kept over 28 plucks spread over a period of one year (2/1/1940-30/1/1941), while the experiment at St. Coombs ran over two years (9/2/54-7/2/56) giving records over 104 plucks at weekly intervals.

2.2 Zonal plucking: results

The findings of De Haan, summarised in table 1, demonstrate the difference between the central and peripheral zones. The former yields appreciably more and produces less banji shoots than the latter

Table 1 *Shoot production of the centre and periphery of the bush* (De Haan)

	Production of centre				Production of periphery			
	No. of shoots	Wgt. in g.	Number of		No. of shoots	Wgt. in g.	Number of	
			Flush	Banji			Flush	Banji
Total	755	651	414	341	591	453	261	329
Average per pluck	26.9	23.25	14.7	12.2	21.0	16.20	9.3	11.7

In this experiment the central part of the bush ($\frac{1}{2}$ of the bush surface) yielded 60 per cent of the total yield.

The results obtained at St. Coombs are given in table 2. In this table the two inner zones have been taken together and the results present the averages computed from the records over two years.

Table 2 *The average production of shoots of centre and periphery plucked above, level with, and below the plucking table for* 5 *bushes*

1	2	3	4	5	6	7
Position of shoots in plucking table	Central zones (4/9th of surface = 452 sq. inch)			Peripheral zone (5/9th of surface = 565 sq. inch)		
	Average No./pluck		Average per 100 sq. inch	Average No./pluck		Average per 100 sq. inch
	All shoots	Banji		All shoots	Banji	
I Above	36.1	8.4 (23.3)	7.8	24.2	5.3 (22.0)	4.3
II Level	21.5	7.6 (35.3)	4.8	18.2	5.9 (32.2)	3.2
III Below	43.1	30.8 (71.5)	9.5	77.3	50.3 (65.0)	13.7
IV Total	100.7	46.8	22.1	119.7	61.5	21.2

N.B. *Figures in parenthesis denote % of banji*

It can be derived from table 2, that the periphery of the bush yielded almost as much per unit area as the centre if total shoots are taken into account (compare column 4 and 7, row IV). However, if only shoots plucked above and level with

the normal plucking table are considered, it appears that the centre yielded significantly more than the periphery (columns 4 and 7; rows I, II). The periphery, though producing considerably more shoots below the plucking table, produces less shoots above and level with the table.

On the basis of yield per unit area and excluding shoots plucked below the table, it can be calculated that the centre half produced 65 per cent of the yield as against 35 per cent produced by the peripheral half of the bush.

It is also worthy of note that plucking below the table more than doubled the total yield of the bush. Namely, if the shoots plucked below are included, the total yield amounted to 220 shoots/pluck/5 bushes as against 100 shoots per pluck for normal plucking (only above and level with plucking table). If plucking below the table is confined to the periphery only, the comparable figures are 177 and 100 shoots.

With regard to banji (columns 3, 6), the table shows that there is little difference between centre and periphery, in fact the former produced a slightly greater percentage of banji than the latter. It is also worthy of note that the percentage of banji for shoots plucked below the table is 2 to 3 times higher than that for shoots above and level with the plucking table.

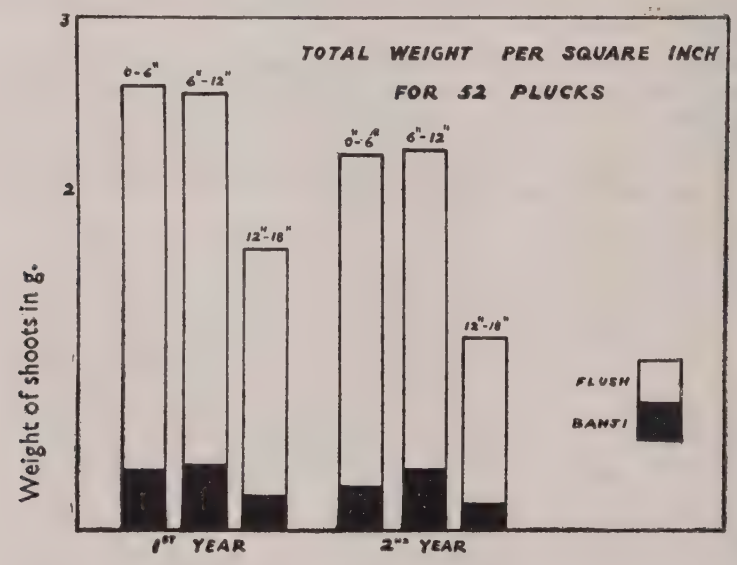

Figure 1. *Shoot production in g. per sq. inch. (exclusive of shoots grown below plucking table) for the different zones of the bush.*

In figure 1 the weight of shoots plucked above and level with the plucking table are given for all 3 zones. This figure illustrates again the greater yield of the central area as compared with the periphery in both years.

2.3. Side-pruning: experimental

In a field at St. Coombs which had run nearly 4 years, the bushes of a number of plots were "side-pruned" in order to investigate a new method of pruning (pre-pruning); that is to say, about 1/6th of the bush on each side along the row was removed. Thus, in total about 1/3rd of the plucking surface was taken away along the periphery.

In one treatment the bushes were side-pruned high (pruning height 3-4″ above last pruning cut); in the other the sides were pruned low (pruning height ½-1″ above last pruning cut). The subsequent yield of the plots treated as above was compared with the yield of non-pruned plots. Each treatment was replicated 6 times: plot-size 1/20th per acre.

At the time of side-pruning the bushes (spacing about 3′ × 4′) touched each other giving a complete cover of tea.

2.4. Side-pruning: results

Figure 2 graphically illustrates the trend in yield per pluck following side-pruning in comparison with the non-pruned controls.

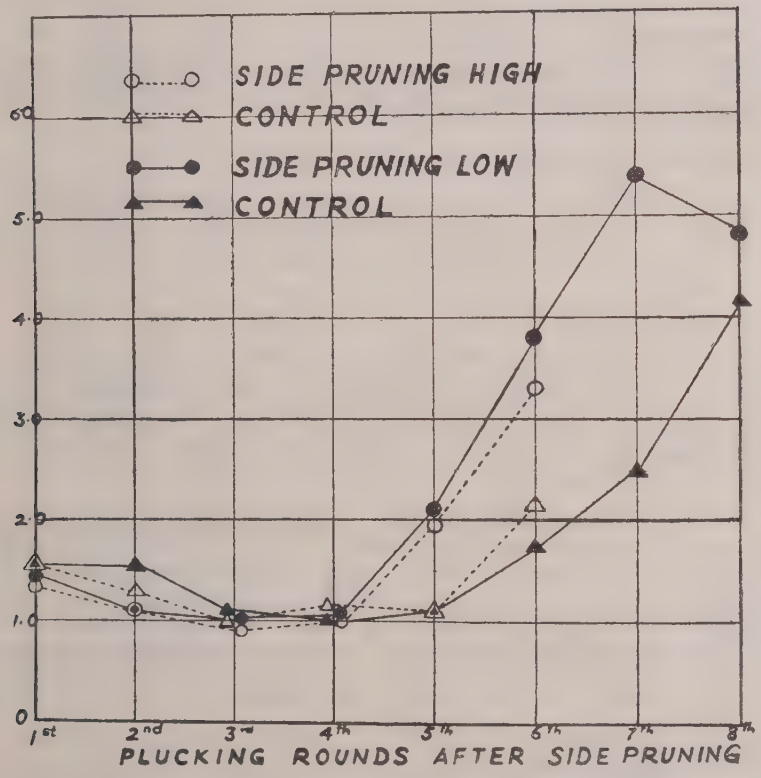

Figure 2. *The effect of side-pruning on yield of full grown bushes.*

It can be seen from this figure that the yield of the side-pruned bushes is initially somewhat less, but later, markedly higher than that of the control, irrespective of whether the bushes were side-pruned high or low. The side-pruned (high) bushes yielded over the first 4 plucks 19 per cent less, but over the subsequent 4 plucking rounds 68 per cent more than the non-pruned bushes.

It is clear from the two ring-plucking experiments and the side-pruning experiment that the centre of the bush produces the greater portion of the yield.

Apparently, towards the periphery of the bush the yield per unit area gradually decreases (if shoots below the table are not plucked!).

This is undoubtedly partly explainable on account of the natural habit of the bush to grow upright rather than to spread. On the other hand, the enhanced yield recorded after side-pruning points to the fact that the decreased yielding capacity of the periphery is also due to competition for light and air. This tendency is likely to become more noticeable with increasing age of the bush after pruning and smaller spacing. In fact, in another experiment where the bushes were less intergrown the effect of side-pruning was less pronounced.

3. Yield in relation to spacing

Since no field experiments have been laid down in Ceylon till now to investigate the optimum spacing of tea, the work done on this subject in Indonesia (3, 4) and India (1) will be reviewed.

3.1. Experimental

In the *Indonesian* experiment seed was planted at stake in January 1927 and was brought into plucking in 1930. The experiment was discontinued in May 1942. The elevation was approximately 5,000 ft.

The following planting distances were compared:—

I	Hedge	— 4′ × 1′ × 3′	: 6,695 bushes counted/acre
II	Rectangular	— 4′ × 3′	: 3,644 ,, ,, ,,
III	,,	— 3′ × 5′	: 2,953 ,, ,, ,,
IV	,,	— 4′ × 5′	: 2,270 ,, ,, ,,
V	Square	— 5′ × 5′	: 1,820 ,, ,, ,,
VI	,,	— 6′ × 6′	: 1,262 ,, ,, ,,

Treatments II, III, IV and V were replicated 5 times, while treatments I and VI were replicated twice; plot size was 1 ha (2.47 acres). The yields were recorded as fresh weights, but are here converted into terms of weight of made tea by assuming that the dry matter percentage of green leaf was 22.5 per cent.

In the experiment carried out by *Tocklai Experimental Station*, two year old seedlings of a light leaf Assam jat were used. These seedlings were planted in April 1949 and came into bearing in 1950.

The planting distances tried out were the following:

A	Rectangular	— 4′ × 2′	: 5,460 bushes calculated/acre
B	Hedge	— 5′ × 2½′ × 2½′	: 4,590 ,, ,, ,,
C	Rectangular	— 5′ × 2½′	: 3,440 ,, ,, ,,
D	Square	— 4′ × 4′	: 2,700 ,, ,, ,,

The four treatments were randomized in 3 replicates, with plot size 0.02 acre.

3.2. Observations

A summary of the results obtained in Indonesia and in Tocklai is given in table 3.

Table 3. *Summarised results of spacing experiments carried out in Indonesia (Pengalengan) 1927-1942 and India (Borbhetta) 1950-1955.*

1	2	3	4	5	6	7
Spacing of Bushes	Number of Bushes per acre	Relative space per Bush	Yield in green leaf per bush in 6th year	Annual Average Yield in lb. made tea per acre		
				Over first 6 years	Over last $3\frac{1}{2}$ years	Over Total $12\frac{1}{2}$ years
INDONESIAN EXPERIMENT						
I 4′ × 1′ × 3′	6695	100	**0.750** (100)	912 (107.9)	1512 (110.0)	1234 (109.2)
II 4′ × 3′	3644	184	1.332 (177)	**876** (100.0)	**1375** (100.0)	**1130** (100.0)
III 3′ × 5′	2953	227	1.752 (234)	891 (101.7)	1441 (104.8)	1171 (103.6)
IV 4′ × 5′	2270	295	2.014 (269)	765 (87.3)	1399 (101.7)	1083 (96.3)
V 5′ × 5′	1820	368	2.273 (303)	688 (78.5)	1394 (101.4)	1051 (93.0)
IV 6′ × 6′	1262	531	3.530 (471)	597 (58.2)	1204 (87.6)	850 (75.2)
TOCKLAI EXPERIMENT						
A 4′ × 2′	5460	100	**0.843** (100)	745 (111.8)	—	—
B 5′ × $2\frac{1}{2}$′ × $2\frac{1}{2}$′	4590	119	0.941 (112)	703 (105.5)	—	—
C 5′ × $2\frac{1}{2}$′	3440	159	1.133 (134)	**667** (100.0)	—	—
D 4′ × 4′	2700	202	1.475 (175)	656 (98.4)	—	—

N.B. *Figures in parenthesis denote the yield in % of the yield of the closest spacing (column 4) or in % of the yield of about 3,500 bushes per acre (columns 5, 6, 7).*

The following remarks can be made:

(*a*) Both experiments indicate that the yield per bush (column 4) becomes greater when the available space per bush increases (column 3). In the Indonesian experiment the increase in production per bush in the 6th year is almost the same as the increase in space per bush for the first 4 treatments (I to IV). In the Tocklai experiment the increase in bush space with wider planting is not entirely matched by an increase in yield ber bush (A to D).

(*b*) In both experiments the annual yield over the first 6 years (column 5) was greater with a greater number of bushes per acre. Spacings giving less than 2,300 bushes per acre were considerably behind in the Indonesian experiment. It appears that when the number of bushes per acre is in the neighbourhood of 3,500 a difference of 700 bushes less has little effect on the yield per ac re over the first period of 6 years (compare: II and III, C and D, column 5.)

(*c*) In the last $3\frac{1}{2}$ years of the Indonesian experiment (column 6), that is from the 10th year, the fields having 1,800-3,600 bushes per acre produced about the same yield, while the narrow spacing (6,695 bushes per acre) yielded more and the wide spacing (1,262 bushes per acre) yielded considerably less.

It is worthy of note that the annual yields of fields with less than 2,270 bushes per acre had increased markedly from the 10th year in comparison with the yields over the first 6 years.

(*d*) The average annual yield over the entire period of 12½ years (column 7) shows that the yield was greater as the spacing of the bushes was narrower. It can be calculated that the narrow planting I, yielded over this period in total 1,387 lbs. tea per acre more than the average of II, III, IV and V, and 4,800 lbs. more than the widest spacing VI.

(*e*) In the Indonesian experiment differences in effect of drought or severity of diseases between treatments were not significant, except for the widest spacing. In the latter case yield decreased during drought and sharp winds and these conditions were usually accompanied by more severe attacks of orange mite than in the other treatments. Similar observations were made in Tocklai.

4. **Practical considerations with regard to spacing**

The experiments carried out in Indonesia and at Tocklai on spacing showed that the closest planted fields (5,500-6,700 bushes per acre) gave the highest yield, especially during the first years. With time, as the bushes cover the available space, the yield of the less closely planted fields catches up. However, it might take as long as 10 to 12 years from the time the bushes start bearing, before *e.g.* 1,800 bushes per acre (5′ × 5′) yield annually as much as 3,600 bushes per acre (4′ × 3′). Hedge planting at a rate of 5,000 bushes or more might be expected to yield over such a period at least 5-10 per cent more than the latter.

Therefore, the advantage of close spacing, whether or not as hedge planting, with regard to yield is clear. Initial costs of planting will be higher, but maintenance costs will be lower, because resupplying will be little or unnecessary as neighbouring bushes will be quickly filling the vacant spaces occurring in the hedge. Also pruning will be simpler. Apart from this, closely planted bushes will also cover the soil more quickly and completely, thus diminishing erosion both after planting and after each pruning, while the yield will be sooner economic.

In this connection it must be mentioned that the experiments in question were carried out with bushes grown from seed. Under Ceylon conditions much of the replanting or new planting is likely to be done with clonal material, especially selected for its vigour and spread.

It has been asked whether such clonal bushes, *e.g.* planted 5 × 2 ft., will not grow so vigorously that, 6-10 years after they have come into bearing, field operations will become difficult. Also whether competition for light and air, particularly along the periphery of the bush might not become so severe so as to constitute a limiting factor to yield. That such might happen can be derived from the ring-plucking and side-pruning experiments which indicated that the yield per unit area markedly decreases towards the periphery.

On the other hand, our observations on *side-pruning* suggested that this operation might partly overcome the possible drawbacks of close planting. That is

to say, when in due time and towards the end of the pruning cycle the rows between the bushes become too much intergrown, side-pruning might be resorted to. Not only that such a practice would facilitate subsequent plucking, but it is also likely that the yield will not much decrease or even increase after side-pruning.

Furthermore, attention might be drawn to *plucking below the plucking* table. Such plucking when carried out along the periphery between the rows will retard the side growth of the bushes, while at the same time the yield obtained will be probably considerably higher. From the ring-plucking experiment on the clonal bushes it would seem that the yield can be considerably increased by plucking the periphery below the table during the first two years.

Eventually it can be said that both side-pruning and plucking below the table along the periphery provide measures to keep a closely spaced plantation in check. However, as our experiments were more or less preliminary ones, further information on the practical application and on the long term effects of these measures are desirable.

The above observations confirm the correctness of the system of contour planting in narrow spaced hedges, now compulsory by legislation, with regard to yield and soil conservation. A few remarks may be made on this subject.

Contour planting will mean that with time the tea fields will gradually tend to get levelled out into a series of contour platforms. It has been remarked that this might be disadvantageous to the root growth of the bush, as the "down-slope" roots will have to originate from a lower point at the stem than the "up-slope" roots. Though initially—during the time that the platforms are formed—some roots at the surface will be disturbed, there is no reason to assume that this would be more harmful to the bush than *e.g.* forking.

The distance between the contour hedges is also a point of consideration. The contour platform will have to be wide enough to make plucking, manuring, cultivation, etc., not too difficult during the second half of the pruning cycle. Depending on soil fertility, vigour and spreading habit of the clones planting up at a distance, *between the rows* of 4-5 ft., and *in the rows* at a distance of 2-2½ ft. can be recommended. That is to say, on a good soil with vigorously spreading clones planting at 5 × 2 ft. or 5 × 2½ ft. will be recommendable, on poorer soil or with clones which tend to grow more upright planting at 4 × 2 ft. or 4 × 2½ ft. might be preferable.

The distance between the rows will also depend on the slope of the field; on rather steep slopes they may have to be somewhat greater than recommended above. Otherwise, the distances—as measured along the slope—may be found too narrow for the unhindered carrying out of field operations.

5. Summary and conclusions

Data were reported and literature reviewed concerning the yield of the centre and periphery of the bush and with regard to planting distances, which can be summarised as follows:—

(1) The central region of the bush, its area depending on spreading habit and environmental conditions, yields more per unit area than the periphery.

(2) At the end of the pruning cycle, when the bushes touch each other, the periphery produces only a small proportion of the yield. Removal of 1/4th to 1/3rd of the surface along the periphery (between rows) at this time resulted in a 20 per cent decrease in yield over the first 4 plucking rounds, but increased the yield by nearly 70 per cent over the 4 subsequent rounds.

(3) Plucking below the plucking table along the periphery, while checking the side-growth of the bush, is likely to give a considerable increase in yield.

(4) The spacing experiments done in Indonesia and Tocklai show that the yield *per bush* increases with wider spacing. This increase is not equivalent to the available space per bush during the first years, so that yield per unit area decreases.

(5) With close planting a quicker cover is obtained resulting in higher yields. Planting at a rate of more than 5,000 bushes from seed per acre gave over periods of $12\frac{1}{2}$ years and 6 years respectively approximately 10 per cent more yield than the planting of about 3,500 bushes per acre.

(6) Side-pruning and plucking below the table along the rows may provide measures to overcome the practical drawbacks of close planting.

(7) Contour planting is recommended at distances not closer than 4 to 5 ft. between rows and 2 to $2\frac{1}{2}$ ft. in the rows, the distances depending on slope, soil fertility and characteristics of the clones used.

Acknowledgments

Our thanks are due to Mr. G. B. Portsmouth who initiated the ring plucking experiment at St. Coombs and to the staff of the Physiology Department for their co-operation in plucking and weighing.

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A NOTE ON THE EFFECT OF DIFFERENT COPPER PREPARATIONS ON TEA YIELD

T. Visser, N. Shanmuganathan and J. V. Sabanayagam

1. Introduction

It has been found that spraying of potatoes with copper fungicides might depress the yield to some extent because of the phytotoxic effect of copper. With regard to tea, however, it is not known whether or not the application of copper preparations at the recommended rate against blister blight adversely affects the yield of tea.

In the 1957 blister blight trials (reported in this *Tea Quarterly**) no reliable differences were found between yields of plots sprayed with different fungicides or between plots sprayed at the normal and at half the normal rates respectively. It was pointed out that any possible phytotoxic effects on yield could have been masked by the incidence of blister blight. Therefore, a subsequent experiment with several copper formulations was carried out at a period during which little or no blister blight occurred, in order to investigate the influence of copper on tea.

2. Methods and material

The possible phytotoxicity of copper spraying was assessed on the basis of yields of plots sprayed with different proprietary brands at the recommended rate of 6 or 8 oz. per acre; untreated plots served as a control. The randomized experiment was laid out on St. Coombs estate and consisted of 8 treatments (7 fungicides and 1 control) each 6 times replicated (in 6 blocks), the individual plots contained about 200 bushes (1/15th acre). The trial started on 28th January, 1958, and was concluded on 30th April, 1958, during which period the plots were 12 times sprayed and plucked at 9 day intervals.

Rain and sunshine during period of experiment.

Month	No. of days with rain	Rain per day	Sunshine per day
February	6	0.03″	7.3 hrs.
March	15	0.33″	7.0 hrs.
April	17	0.26″	6.0 hrs.

The weather, as can be seen from the above data, was dry and sunny in February, while March and April had a fair amount of rain which was on average not much less than the average daily rainfall in the South West monsoon. However, the amount of sunshine per day was considerably greater than during typical monsoonal weather.

The blister blight incidence was negligible throughout the period; the average percentage of infected shoots (third leaves) on 27th January, 22nd February and 27th March was 8, 4 and 10 per cent respectively on the unprotected plots.

3. Results

The total yields obtained over the period on the plots sprayed with the different formulations are given below.

Yield in relation to spraying with copper fungicides over a period of 12 *plucks.*

Treatments	Rate per acre per round		Yield** made tea	
	Total	Copper	in lb.	in %
Control: unprotected	0	0.0	130.0	100.0
Fitox: 16% coated copper oxychloride	8 oz.	1.3 oz.	120.8	92.9
Duphar: 26% colloidal copper oxychloride	6 oz.	1.6 oz.	129.2	99.4
Cupravit blue: 35% copper oxychloride	6 oz.	2.1 oz.	133.4	102.5
Cobredon: 45% copper carbonate	6 oz.	2.7 oz.	129.1	99.4
Shell Copper: 50% copper oxychloride	6 oz	3.0 oz.	120.8	92.9
Copper Sandoz: 50% copper oxyde	6 oz.	3.0 oz.	121.1	93.1
Perenox: 50% copper oxyde	6 oz.	3.0 oz.	128.7	99.0

**yield per 1,200 bushes.

The above figures show that the yields vary only little, irrespective of the type of copper fungicide and the amount of metallic copper applied. None of the differences between the yields of plots sprayed or unsprayed were statistically significant (determined by "analysis of variance"). These results, obtained at a time when blister blight was negligible confirm those which were earlier obtained during the S.W. monsoon*). That is to say, the spraying of fungicides of different formulation and copper content was found to have had no significant depressing effect on yield during both periods. This is not surprising as the amount of copper applied per round on tea is more than ten times less as compared with that applied on a crop like potatoes. Moreover, the rainfall during a monsoonal period is markedly greater that than during a summer in the temperate zone, so that a greater proportion of the copper will be washed off in the former case.

It can be concluded, therefore, *that spraying with copper fungicides at the normal rate will have no appreciable phytotoxic effect on tea.*

*) VISSER, T., SHANMUGANATHAN, N. AND SABANAYAGAM, J. V.: Blister blight control in 1957 with respect to fungicidal formulation, application rates and yield. Tea Quarterly **29** (1) 1958.

SOME OBSERVATIONS ON THE BEHAVIOUR OF THE ADULT SHOT-HOLE BORER *(XYLEBORUS FORNICATUS* EICH) UNDER LABORATORY CONDITIONS

E. Judenko

1. Introduction

According to METCALF (1955)—"The pronounced effectiveness of DDT and other contact insecticides to insects walking or resting on residually treated surfaces indicates that the tarsi are important sites of entry of contact poisons." It appears therefore that konwledge of the behaviour of the adult shot-hole borer beetle outside their galleries is important when considering the use of contact insecticides against this pest.

Although the investigation into the behaviour of beetles on tea bushes was conducted under laboratory conditions, it is assumed that such movements as were observed would not be dissimilar to the behaviour of adults under natural conditions in tea fields. Further, the appearance of beetles in the soil, based mainly on laboratory observations, would indicate the necessity to investigate this phase too, under natural conditions by a closer examination of the soils carrying tea infested with shot-hole borer.

If a large number of live beetles (outside their galleries) could be found in the soil field trials might be laid down to ascertain the effects of various chemicals on such beetles.

2. Experimental

Observations on the behaviour of beetles were confined to two bushes (artificially infested) and the soil in which the bushes were planted. The two bushes were established in barrels placed on a covered verandah laboratory at Millawitiya Estate, Ratnapura, elevation about 400 feet above sea level. At the time of observation the two bushes were about 4 years old from planting, 2½ feet and 4 feet high respectively, with a maximum diameter of about 3 feet.

HOGAN (1948) investigating the life history of one of the Ambrosia beetles found that the adults could be kept alive for a considerable length of time by confining them, on emergence, in damp sawdust. In the laboratory experiments (described later) adult beetles, utilized for artificial infestation, were limited to those beetles which were extracted from dissected prunings in preference to those which emerged from galleries. Damp sawdust was put into cones made from cardboard and placed around the branches of the tea plants at different heights. 349 males and 2489 females were then introduced into the cones between 16th October and 23rd November, 1956. When after sometime (6 to 11 weeks after the introduction of the beetles) the cones were removed, 252 entrance holes or open galleries were found distributed between the two bushes. The majority of the galleries found were confined to those parts of the bushes which were not more than a foot above ground level. Observations on the freshly emerged adults (**i.e.** the progeny of the beetles introduced in October/November 1956) were started on 2nd January, 1957. The

first adult to emerge from a gallery was seen on 4th January, **i.e.** 42—80 days after artificial infestation. Observations continued until 9th February (78 to 166 days after the 1956 infestation) when the last adult was recorded to emerge. It should be stated here that according to Gadd (1949) "the life cycle (of shot-hole borer) at 3000 to 3,500 feet would occupy 6 or 7 weeks."

Observations at Millawitiya were carried out daily from Monday to Friday from 7-30 a.m. to 4-15 p.m. and on Saturdays from 7.30 a.m. to 11.45 a.m. No observations were recorded on Sundays and neither on Monday 4th February as it was a public holiday. Every 10 minutes, both bushes and soil surface were examined and if a beetle was seen emerging from a gallery or walking on the branches or soil surface its behaviour was uninterruptedly observed and noted until its final fate was known or the daily time of observation was over. In the majority of cases beetles were not seen emerging from the galleries but were noticed walking on the branches or soil surface after their emergence. Therefore the actual time spent out of the galleries was from 1—9 minutes longer than that described below. No fresh emergences were ever observed to occur after 2-30 p.m. Observations at night were carried out once—from 6 p.m. on 10th January to 7-30 a.m. the following day; no beetles emerged from their galleries during this period. There was hardly any wind during the time of observations and conditions were considered as windless. Only such adults as were alive at the first time of observation are considered below. 33 such adults were observed, 4 (12%) being males and 29 (88%) females.

3. Behaviour of the beetles

3.1 Male beetles.

Of the males observed 3 were yellow and 1 was black. The movements of the black male were quick and those of the yellow males slow. The black male walked on the stems and branches at a height of 3-12 inches above ground level for about 40 minutes. It also entered 4 old galleries where it spent about 55 minutes. One of the galleries was entered in turn 6 times, another one twice and the remaining two galleries were entered once. Finally it entered an old gallery and was not seen for about 1 hour, after which time the daily observation was over.

Of the 3 yellow males one was seen walking and stopping on the tea bush at a height of 5—9 inches above ground level for 7 minutes and its further fate was unknown. The second yellow male walked on the base of the plant to a height of $1\frac{1}{2}$ inches for 13 minutes. It afterwards moved on to the soil surface where it continued to walk at intervals for about $3\frac{1}{2}$ hours. Several times it burrowed into the soil where it spent about $1\frac{1}{2}$ hours. About 2 hours before the daily observations were concluded it entered the soil and its further fate was unknown. The third yellow male walked for about 17 minutes on the plant at a height of 3—11 inches above ground level. It also spent 15 minutes inside 3 old galleries entering one of them 3 times in turn. It later dropped to the soil and walked on the surface for about 40 minutes. It spent 8 minutes in the soil digging in 5 times and coming out again, and finally died on the soil surface.

Discussing the colour of the adults of the Ambrosia beetles Fisher *et al.* (1953 and 1954) state "Upon emerging from the pupal cases the beetles are pale yellow with dark patches marking the eyes and mouth parts. In a short time they turn to the dark brown or black of the mature adults." This would indicate that the yellow males of shot-hole borer described above are probably immature ones.

3.2 Female beetles

Of the 29 females observed 27 were seen for the first time on tea plants and the other two were seen for the first time on the soil surface. Of the 27 females that were seen for the first time on the tea plants, 13 dropped to the soil surface or walked there. The details were recorded in Table 1.

Table 1. *Behaviour of female beetles.*

Number seen on tea plants only	Number seen on the soil surface				Grand Total
	Seen dropping from tea plants	Seen walking at the base of the tea plants	Seen for the first time on the soil surface	Total	
14	8	5	2	15	29

Some of the 8 females that dropped on to the soil surface crawled back on to the plants and dropped off again. Some of the 5 females that were seen at the base of the plants walking to the soil surface returned again to the bush and afterwards returned back to the soil surface. In the case of one female this was repeated 4 times. Of the 15 females that were seen on the soil surface 6 dug into the soil and the remainder (9) were seen only on the surface.

Of the 6 females that dug into the soil one, having been in the soil for about 2 minutes, crawled on to the plant and entered an old gallery; three were found dead in the soil at a depth of $\frac{1}{2}$—1 inch, while the fate of the other two is unknown. Six of the 9 that were observed only on the soil surface (but did not dig in) went back to the plants, having been on the surface for periods varying from $\frac{1}{2}$ minute to about 1 hour. During this time the females moved in a zigzag fashion over distances ranging from about 1 inch to about 2 feet, stopping from time to time. Of the remaining three, one flew away, one died and the fate of the third is unknown. Some of the females which were seen on the tea plants only and some of those which returned to the plants from the soil either entered old galleries, made new galleries or flew away.

The fates of all observed females are recorded in Table 2 in relation to the period during which the daily observations were carried out.

Table 2. *Fates of female beetles.*

Group Number	Fate	Number observed	Number seen for first time during each period	
			7-30 a.m. to 11-00 a.m.	11-00 a.m. to 2-30 p.m.
I	Entered old galleries	11	7 (64%)	4 (36%)
II	Made new galleries	5	0 (0%)	5 (100%)
III	Flew away, being on the plants or soil surface	6	1 (17%)	5 (83%)
IV	Died after the beginning of the observation, being on the soil surface or in the soil	4	2 (50%)	2 (50%)
V	Fate unknown	3	1 (33%)	2 (67%)
	Total	29	11 (38%)	18 (62%)

Some of the females of Group I entered several old galleries or one gallery several times and came out again. Finally they disappeared into the old galleries. Among the 27 females which were seen on the plants, 17 moved no higher than 1 foot above ground level, 9 walked partly between 1 foot and ground level or partly above 1 foot. Only one female moved entirely at a height greater than 1 foot.

The average time spent on the plants by the females was 31 minutes for Group I, 8 minutes for Group II, and 11 minutes for Group III. Out of the total of 29

females two in Group II were yellow and the remainder (27) were black. In groups II and III the movement of the females was quick, whilst in the other groups it was slow. Considering only these females comprising Groups I, II and III one can suppose that those of Group I represent the immature stage of the adult (although only two of them were yellow) while those of Groups II and III the mature stage, but only anatomical examination can prove this assumption.

4. Summary

(1) Of the 33 emerged live adults observed 88 per cent were females and 12 per cent males.

(2) Some of the emerged females entered old galleries, others made new galleries while still others flew away or died.

(3) Some of the adults either dropped on to or walked to the soil surface under windless conditions.

(4) Some of the adults which were on the surface of the soil also burrowed into the soil.

(5) The great majority of the adults were walking at least for some time on that part of the plant not higher than one foot above ground level.

(6) It is assumed that not only mature beetles but, on occasions, immature adults as well, appear outside their galleries.

Acknowledgment

The writer expresses his thanks to Mr. C. Shanmugan, his Assistant, for help in the work.

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TRIALS WITH A METHOD OF ASSESSMENT OF INFESTATION CAUSED BY SHOT-HOLE BORER *(XYLEBORUS FORNICATUS* EICH.) ON OLD TEA

E. Judenko

The method of assessment as presented in this article furnishes greater detail than that described in a previous paper (JUDENKO, 1956), the primary object of which was to find a standard unit which would both be easily available and contain the maximum number of galleries.

Work on the establishment of a suitable standard unit was divided into three parts: (1) Initial selection of length of unit and diameter at base, (2) Final selection of diameter of base, and (3) Final selection of length of unit and diameter at top.

1. Initial selection of length of unit and diameter at base

The following method was applied during examinations carried out on 8 tea fields. All live parts of branches, termed here units, of a minimum length of at least 4 inches, were measured. Parts of branches of length shorter than 4 inches were not considered as the number of galleries in them would be small. Therefore the unit was confined to a 4 inch minimum length of the stem between two axils, provided it was approximately circular and carried no green shoots.

Diameter measurements were taken with a gauge of 1/16 inch accuracy. The diameters investigated varied from 5/16 inch to 12/16 inch. Parts of branches with diameter smaller than 5/16 inch were not examined because the numbers of galleries were too small and branches with diameters larger than 12/16 inch were rare.

400 units from each of the 8 fields were examined and these were taken from mature bushes selected at random. All available parts of living branches were examined until 400 units were found.

Examinations were carried out from May-July, 1956, in the fields listed in table 1.

Table 1. *Details of fields chosen for trials*

Estate	Field No.	Age after planting (years)	Age after pruning	Length of pruning cycle (years)	Type of pruning	No. of bushes from which 400 units were obtained
Palmgarden	Clearing 1952	4	—	—	—	24
Mahawela	Clearing 1950	6	10-15 days	2	Cut across	35
Mahawela	Clearing 1948	8	23 months	2	Cut across	24
Millawitiya	1	Approx. 31	2-10 days	2	Cut across	28
Millawitiya	6	Approx. 31	22 months	2	Cut across	17
Nayabedde	11/19	37-54	10 days	4	Cut across	26
Nayabedde	17/31	42-44	10-14 days	4	Clean	11
Nayabedde	4/24	44-67	17 months	4	Cut across	20

The results of these examinations showed that, of 3,200 units measured, the most frequently found were those of 6/16 inch diameter at base and 4-5 inches in length, as well as those of 7/16 inch in diameter at base and 4 inches in length The corresponding details are furnished in table 2.

Table 2. *Details of units found.*

Diameter at the base	Length	Number of units per bush			% of bushes with at least one unit available		
		Min.	Max.	Avg.	Min.	Max.	Avg.
6/16″	4″	3.1	7.8	4.5	86	100	94
6/16″	5″	2.7	6.9	4.0	77	100	91
7/16″	4″	1.8	6.0	3.4	80	100	92

Tables 1 and 2 show that the units were found in tea fields of different ages and at different times after pruning, from which it can be assumed that they will be available on all tea plantations in Ceylon by at least 4 years from planting. Data given in table 2 show that units 6/16 inch in diameter at base and 4 inch in length were most common.

2. **Final selection of diameter of base**

In the following examinations units 6/16 inch in diameter at base and top were compared with those of 7/16 inch in diameter. All units examined were 4 inches long and were collected from 5 tea fields on 4 estates.

The bushes examined were from 8 to 56 years old and from 3 to 23 months from pruning. 100 units of each of the sizes mentioned above were taken from each field. Only one unit of these sizes was taken from each bush and samples were taken from different parts of the fields.

In the laboratory the bark of each unit was first examined. If stripes appeared only on a small part of the surface, or did not appear at all, it was considered to be old bark. Each unit was next split lengthwise into four parts. The galleries then found were classified as follows: those whose entrances were found open on the unit were termed "obviously open galleries"; those whose entrances were closed were called "healed galleries". Yet another type of gallery appeared on the units examined. These galleries had their entrances on the branches from which the units had been cut and it was unknown whether these entrances were open or healed. They were considered as "unknown galleries". Both the healed and the unknown galleries were classified together as "other galleries". The results of these examinations are given in Table 3.

Table 3. *Comparison of units of different base diameters.*

Diameter at the base and top of units	Length of units	Number of units examined	No. of units with young bark	Number of galleries		
				obviously open	other	Total
6/16″	4″	500	101 (100%)	116 (100%)	422	538 (100%)
7/16″	4″	500	41 (41%)	99 (85%)	543	642 (119%)

Table 5.—*Details of assessments*

1	2	3	4	5	6	7	8	9
Examination No.	Date of Examination	Estates and Divisions	Field No.	Age after planting (years)	Age after pruning (months)	Approx. Elevation (ft.)	Total number of galleries in 50 standard units	Opinion of Superin-" tendents
1	15-11-1956	St. Coombs	5	Approx. 60	39	4,700	0	—
2	15-11-1956	St. Coombs	9	Approx. 30	10	4,500	0	—
		Galkondura Div.					89	
26	21- 6-1956 2- 7-1956	Madampe Group, Div. No. 2	4	Approx. 40	3	1,000-1,500	93	+
27	25- 9-1956	Hantane	12	29, 40, 41	0-2	2,200	95	+
28	26- 9-1956	Hantane	2	70	21-22	2,100	105	+
29	21- 2-1957	Deniyaya, Longford Div.	2	60	2	2,500	108	?
30	22- 1-1957	Dundanell	2	Approx. 25	32	2,300	129	+
						Average	48	

" **Note.** — Means that according to the Superintendent shot-hole borer does not cause loss of yield.
+ Means it causes loss of yield.
? Means influence of shot-hole borer on the yield is unknown.

Although there are indications that the total number of galleries was larger in the case of units of base diameter 7/16 inch, units of the diameter 6/16 inch were selected for the following reasons. Young bark was more frequently found among units of diameter 6/16 inch; in other words heterogeneity of young and old bark was better represented. There was also an indication that in the case of units of 6/16 inch the obviously open galleries were more numerous. This is an important factor in the case of the assessment of the infestation because of the presence of live insects inside them. Finally, as can be seen from table 2, units of 6/16 inch diameter were found more frequently than units of 7/16 inch diameter.

3. **Final selection of length of unit and diameter at top**

In addition to the units described in the previous paragraph, further samples for these selections were also collected. Details of all units examined are given in table 4.

Table 4.—*Comparison of units of* 6/16 *inch base diameter and of different lengths and top diameters*

Length of unit	Number of units examined	Diameter at top						
		6/16″			5/16″		Other sizes	
		No. of units	%	Number of obviously open galleries per unit	No. of units	%	No. of units	%
4″	612	417	68	0.27	169	28	26	4
5″	494	314	64	0.32	154	31	26	5

Units 6/16 inch in diameter at top were selected as they are more predominant. Although there was an indication that the 5 inch units contained a greater number of "obviously open" galleries, the 4 inch units were selected for the following reasons: as can be seen from table 2, units of this size were found more often than those of 5 inch length. It appears, also from table 2, that the number of units 4 inches long and 6/16 inch diameter at base is on an average 4.5 per examined bush. Table 4 shows that among such units only 68 per cent have a diameter of 6/16 inch at the top, so that the corresponding number of units of diameter 6/16 inch at base and top would be 32 per cent less than was shown in table 2. This would mean that on an average 3.1 of such units could be obtained per bush.

It should be finally emphasised that the data given in tables 2 and 4 are confined to only a limited number of fields and it is, therefore, very probable that there are fields where the units appear less frequently than has been indicated in these tables. The easy collection of units is a very important factor, hence the selection of the 4 inch long units.

On the basis of the investigations described, a standard unit for the assessment of shot-hole borer infestation of bushes 4 years of age and older was selected and defined as *a piece of live branch 4 inches long, 6/16 inch in diameter at base and top, and free of any secondary branch or green shoot.*

4. **Trial assessment of shot-hole borer infestation in individual tea fields**

Results of observations on 30 tea fields situated in different parts of tea growing areas, are tabulated in column (8) of table 5.

The standard units were collected from bushes at approximately equal distance apart from one another and confined to those growing along roads or paths. 55 standard units were collected from each field, but only 50 examined in the laboratory. Depending on the size of the fields and the number of suitable units, it took two assistants from 1 to 2 hours to collect them; an exception was in the case of No. 14 field (3 years after planting) where the collection took a longer time. Standard units were easily available and confirm investigations carried out during the initial establishment of the method. Occasionally more than 55 standard units were collected and more than 50 were examined. In all such cases the average number of galleries per 50 standard units is given in column 8 of table 5.

The units were then checked up in the laboratory for size and appearance of bark (*i.e.* new or old); they were next dissected longitudinally into 4 parts and the number of galleries counted.

Comparison of results of the above examinations indicated that units with young bark had an average of only 0.57 galleries per unit (max. 2, min. 0), while those with old bark had 1.11 (max. 7, min. 0) galleries per unit. The percentage of units with young bark varied from 2 per cent to 66 per cent, with an average of 25 per cent for all examinations.

In view of these observations it would perhaps be advisable at future examinations to collect equal number of units with young and old bark.

An assessment of shot-hole borer infestation on any particular field can be undertaken for the purpose of studying the distribution of the pest in relation to climatic conditions, elevation, methods of cultivation, etc., or for purely statistical purposes. The data recorded in tables 5-8 can in no way be considered conclusive owing to the differences in the infestation of standard units of young and old bark, and because of the very small number of fields examined. It appears, therefore, that the data in tables 5-8 should be considered as very approximate indications of the assessment of shot-hole borer infestation.

The opinions of the Superintendents of estates examined regarding the influence of shot-hole borer infestation on the yield of tea are indicated in Table 5. Although numerous galleries were found in some of the fields where, according to the Superintendents, shot-hole borer causes loss of yield, this qualitative relationship should be considered only as an indication of the need for further detailed studies. The data assembled in tables 6-8 are taken from column (8) of table 5.

Table 6.—*Number of galleries in* 50 *standard units in relation to elevation.*

Elevation (feet)	50-1,000	1,000-2,000	2,000-3,000	3,000-4,000	4,000-6,000
No. of fields	14	5	6	1	4
Range	11-89	34-93	59-129	—	0-4
Average	34	62	96	84	1

Table 7.—*Number of galleries in* 50 *standard units in relation to age of tea from planting.*

Time after planting (years)	3-10	11-20	21-30	31-40	41-50	51-60	70
No. of fields	5	2	4	7	6	5	1
Range	32-68	30-31	0-129	4-95	11-84	0-108	—
Average	46	31	70	41	37	52	105

Table 8.—*Number of galleries in 50 standard units in relation to age of tea from pruning.*

Time after Pruning (Months)	0-5	6-10	11-15	16-20	21-25	31-35	39
No. of fields	8	6	2	5	3	5	1
Range	0—108	0-40	14—18	11—74	62—105	4—129	0
Average	65	22	16	41	78	66	0

Table 6 indicates that fields situated above 4,000 feet were either not infested or infested to a very small degree only. Fields situated below 1,000 feet were seldom infested to a high degree. The highest infestation was found in fields situated between 2,000-3,000 feet.

Table 7 indicates that tea plants below 10 years of age can sometimes be infested to a high degree, and that on the other hand, older tea can be infested to a small degree only.

Table 8 indicates that, on the average, the highest degree of infestation occurred in the fields examined in 0-5 and 21-35 months from pruning. The remaining fields were infested to a lower degree but it should be stated that all of them, except for three, were situated either below 1,000 feet or above 4,000 feet.

It can be seen from the data furnished in tables 6-8 that of the factors considered, elevation, age of tea from planting and age in the pruning cycle, elevation influences the degree of infestation to the greatest extent.

5. **The assessment of shot-hole borer infestation in field experiments.**

The purpose of an assessment is to estimate the influence of the treatment on the pest. The methods of assessment of shot-hole borer infestation hitherto adopted in this country by Gadd and Jepson, and others, are described in detail in their publications and only the main points are, therefore, discussed here.

The assessment of Jepson and Gadd (1922) consisted of periodical counts of the open galleries on 25 bushes from each experimental plot and an examination of the contents of galleries in the prunings.

Jepson and Gadd (1925 and 1926) in adopting their earlier method also counted the number of healed galleries on the 25 bushes from each experimental plot.

Gadd (1941 and 1942) clean pruned 10 bushes from each experimental plot at three week intervals and recorded the number of healed, vacated, abandoned, and occupied galleries in the prunings.

In a further experiment of Gadd (1943, 1944a, 1944b, 1944c and 1949) the assessment consisted of weekly counts of the number of broken branches from the whole experimental area. In some cases weight of the broken branches were determined and the number of empty and occupied galleries and their contents examined. Some of the prunings were also dissected and the number of open and healed galleries recorded.

While it is agreed that at normal pruning time the assessment of infestation of the pest should be carried out on a large quantity of prunings it is considered that the standard unit method might be found suitable for assessing the degree of attack

at various intervals between prunings. The applicability of this method can only be determined by experiments and hence only the general points are discussed here.

It would perhaps appear that, depending on the nature of the experiment, different parts of the standard units should be examined. If interest is in general infestation only, it would perhaps be sufficient to examine only the total number of galleries. On the other hand, in some experiments estimation of the direct influence of treatment on the insects can be important, *e.g.* in experiments where the bushes are treated with contact insecticides, so as to prevent the female beetles from making galleries, not only the total number of galleries but also the number of live adults and perhaps of "obviously open" galleries should be examined.

Two examinations were carried out to test the applicability of the method.

5.1. Examination at Ingiriya Estate

Field No 5 planted in 1930. The Tea Research Institute has been carrying out since 1952, experiments to determine the influence of the length of the pruning cycle on the yield of tea and on shot-hole borer infestation. Between 26th November and 3rd December 1956 10 experimental plots, 1/10 acre each were examined. For the purposes of the test, data from the $2\frac{1}{2}$ year cycle plots alone are shown. These are pairs of plots treated identically in different blocks. Data regarding yields were kindly supplied by Dr. A. W. R. Joachim, O.B.E. 45 standard units were collected from each plot, but only 40 were examined. It took five assistants an average of 17 minutes per plot to collect them.

According to the Superintendent shot-hole borer does not cause loss of yield in this field. Average data for the examined area per 50 standard units are as follows: live adults 4, total number of galleries 20. Comparison of the last figure with the data given in column (8) of table 5 shows that infestation was low. Results of the examination are recorded in Table 9.

Table 9.—*Results of examination at Ingiriya Estate.*

Plotnumbers	Yield from 9-6-1952 till 30-11-1956		Number of Standard units examined	Units with young bark		Galleries				Live Adults	
						Total		Obviously open only			
	Lbs/ acre	Ratio		No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
A5, B5, C5, D5, E5	2,231	100%	200	46	100%	76	100%	16	100%	19	100%
A6, B6, C6, D6, E6	2331	105%	200	46	100%	85	112%	16	100%	9	47%

5.2. Examination at Galbode Estate, Galkondura Division

Field No. 9, planted in 1947 and last pruned in August 1955. 10 plots, 1/10 acre each, were marked on this field. They were placed in one row and numbered successively. Standard units were collected on the 5th and 6th February 1957. Although only 40 units were examined, in order to find out how long it would take to collect a larger number of units, 65 were collected from each experimental plot. It took 5 assistants on an average of 21 minutes per plot to collect these. According to the Superintendent, shot-hole borer caused loss of yield in this field. Average data for the examined area per 50 standard units were as follows: live adults 58, total number of galleries 65. Comparison of the last figure with the data given in column (8) of table 5 shows that the infestation of the examined area can be considered as high. Results of the examination are recorded in Table 10.

Table 10.—*Results of examination at Galbode Estate.*

Plot numbers	Number of standard units examined	Units with young bark		Galleries				Live adults	
				Total		Obviously open only			
		Number	Ratio	Number	Ratio	Number	Ratio	Number	Ratio
1, 3, 5, 7, 9	200	114	100%	261	100%	204	100%	245	100%
2, 4, 6, 8, 10	200	125	110%	268	103%	196	96%	230	94%

In both examinations standard units were collected at random. As the early emergence of adults from the units was possible, they were examined on the days of collection. In the laboratory the sizes of the units were checked up, and after an examination of the bark, they were dissected into 4 longitudinal parts and the number of galleries and live adults counted.

The data given in Tables 9 and 10 show that there were no significant differences in the total number of galleries and of "obviously open" ones in the two sets of plots. In other words there is an indication that, in the case of the experiments described above, the method described furnishes an assessment of the degree of shot-hole borer infestation by examining 40 units per plot. The same tables show that there were also no significant differences in the number of units with young bark between the two sets of plots. As for the number of live adults, no differences between the two sets of plots appeared in the examination carried out at Galbode. In the case of the examination carried out at Ingiriya the number of beetles were too small to make any positive deduction.

Only such treatment of the tea bushes as would both decrease the total infestation of the shot-hole borer and increase the yield, can be considered as satisfactory. Examinations carried out at Ingiriya (Table 9) show that there were no significant differences either between the yields of the two sets of plots or the number of galleries per 200 standard units. It would therefore appear that this method is likely to be of use in experimental work.

Any disadvantages of the method may be realised with further trials, but some of its limitations can be pointed out here. Firstly, the method is not applicable to tea plants younger than three years and, as for older bushes, only branches with 6/16 inch diameter at base and top can be utilised.

6. Summary and Conclusions

(1) A piece of live branch, 4 inches long, 6/16 inch in diameter at base and top, and free of any secondary branch or green shoot, is taken as a standard unit.

(2) Trial assessments of 30 fields indicated that fields situated above 4,000 feet elevation were either not infested or infested to a small degree only. Fields situated below 1,000 feet were in general infested to a small degree. The highest infestation was found in fields situated between 1,000-4,000 feet.

(3) It appears that the standard unit method may be suitable for assessing the degree of shot-hole borer infestation in field experiments at intervals between prunings.

(4) This method of assessment needs further investigation.

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The writer expresses his thanks to Mr. G. B. Portsmouth, former Director of the Institute for suggesting the standard unit method, and to Superintendents of estates visited for facilities afforded.

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*FURTHER OBSERVATIONS ON MITE ATTACKS IN HAPUTALE DURING 1957

C. N. J. Mulrenan
(Gonamotava, Haputale)

The previous article appearing in the *Tea Quarterly* of March/June 1957 was prepared early in January. These further observations and conclusions cover the period January to September, 1957.

Weather.—Weather conditions during the N. E. monsoon period January to early June followed a more normal pattern than last year. With the exception of a dry spell during the latter part of March and early part of April, rainfall was up to average and well distributed.

The S.W. monsoon period has, however, proved to be the second driest in the past 62 years, the previous lowest rainfall for this period being recorded in 1922.

General Observations.—A carry over of all the four species of mites from the previous year became apparent early in January, and during the dry spell of weather in March a significant build-up occurred. Weather conditions, however, being favourable for quick leaf growth, few instances of defoliation were observed, and crop for the rush season easily surpassed all previous records.

From mid July onwards conditions for the spread of mites became most favourable, and defoliation due to scarlet mite attacks in particular, was being accelerated by the rapid drying out of the soil.

The distribution of the various mites throughout the estate followed much the same pattern as in the previous year, but with a few significant variations.

Scarlet Mite.—Although a few mites were seen on isolated bushes at the highest elevation of the estate—5,700 ft.,—the severity of attack appeared to be less than last year and very little damage occurred above 4,600 ft. Attacks were again most severe in the poorer gravelly areas of the estate; fields in their 2nd and 3rd years suffering the most heavily.

Purple Mite.—This mite has become more widespread, and particularly favours the younger fields. For the first time it has been observed in large numbers in a young field above 5,000 ft.

Yellow Mite.—This is confined to the lower fields, and is most prominent on the younger tea.

Red Spider.—The increase of this spider mite has been most noticeable, and although mainly to be found at a lower elevation, is firmly established in tea of all ages.

Observations on Pest Control Measures.—**Mature Tea.**—Tea sprayed with both tainting and non-tainting acaricides during 1956 remained comparatively free of the pest until June, 1957, but the severity of attacks is, after about 10 months, now similar to last year before treatment was given.

**The Institute does not necessarily endorse the view expressed in papers contributed by persons other than members of the staff.

Pruned Tea.—Post pruning sulphur treatment was given to one field in August last year, and another field in February of the current year.

In the former field, although no mites were observed in the early part of the year, purple and yellow mites were present in appreciable numbers by June, and scarlet mite attacks developed in July and August.

In the latter field, purple and yellow mites had effected a heavy build-up after 4 months from spraying, but scarlet mite was not noticed until after about 6 months. One acre of this field was left unsprayed as a control, but there is now no visible difference between the mite population of the sprayed or control areas.

As mentioned earlier, the fields sprayed last year again became heavily infested with scarlet mite and purple mite, and a second course of treatment proved necessary.

Control Measures During 1957.—Control measures for scarlet mite were initiated early in March in areas of tea containing a significant mite population, and which had not received any protection the previous year. The scope of this work was restricted as stocks of non-tainting acaricides became exhausted. Fresh stocks did not become available until the end of June, when the programme was continued. By this time, however, the mite population had increased considerably, and at the time of writing, those fields sprayed earlier in the year present a more healthy appearance than fields sprayed during the dry weather.

Dusting.—Experimental dusting over a small area was carried out during March, and a mite count taken in July showed an almost complete absence of scarlet and purple mite, and red spider, whereas leaf samples taken from an adjoining control area showed a heavy infestation of all three species. A further larger dusting experiment is at present in hand, alongside an area receiving spray treatment, leaving an isolated area of tea as a control.

Two types of acaricidal dusts are known to be on the market at the present time, there being a very wide difference between the prices of the two. One dust is priced at Rs. 1/50 per lb. and the other at -/45 cts. per lb. The cheaper material only has been used in the experiment, the cost per acre for a course of treatment of 3 rounds at 30 lbs. dust per acre, approximating closely to that of non-tainting acaricidal spraying, *i.e.* between Rs. 40/- and Rs. 45/- per acre. The use of the more expensive material would result in the prohibitive cost of over Rs. 120/- per acre.

The use of dust for control appears to merit consideration when:

(*a*) water is in insufficient quantity for spraying.

and (*b*) the tea is of such a size and density to preclude the successful manipulation of sprayers and application of the spray.

The application of dust by means of manually operated machines requires a technique similar to that for spraying, each bush receiving individual attention. There is, therefore, little difference between the labour costs of the two forms of control, and unless additional dusting machines are acquired, the normal number to be found on the average estate for use in blister blight control would enable only a very limited acreage to be treated at one time. Power driven dusters are now being tried out elsewhere, but results are not as yet known.

Future Policy.—As a result of observations made during the past 18 months the following points of policy are to be adopted during the coming year. It is emphasised, however, that these conclusions are those thought to be best for this particular estate having an Uva climate, and are not necessarily applicable to other districts.

(a) Pruning.—The present policy of the estate is to prune down approximately 50% of the scheduled acreage between January and March, with a view

to reducing rush crops. The acreage to be selected for early pruning is to be taken from the higher part of the estate, as experience has shown that yellow mite causes no damage at the higher elevation. As this mite is most virulent during the S.W. monsoon period in fields recovering from pruning, the lower fields pruned during the dry weather months, will be recovering into wet weather and should not suffer any set-back from yellow mite damage.

(b) Post-pruning treatment.—Results of past treatment have not come up to expectations, and this work is to be discontinued.

Fewer lungs and maintenance foliage are to be left at the time of pruning where this is thought not to affect the health of the bush, to reduce to a minimum any carry over of mites to newly forming foliage.

(c) Spraying. No treatment so far given has provided any degree of immunity beyond about 10 months. It now appears inevitable that certain fields will be subject to annual attack and that a routine spraying programme, as for blister blight control, is therefore necessary. The peak period for mite attacks can occur from any time between mid July and the end of September, depending on rainfall distribution, and the date of the start of the N.E. monsoon rains. The optimum time for the application of acaricides appears to be not less than 2 months and not more than 5 months before the time that an attack reaches its peak. It is, therefore, proposed to initiate control measures from about mid March, completing the programme by mid May at the latest. During this period, the blister blight spraying programme is progressively reduced, and with a significant number of sprayers and adequate labour available no difficulty is anticipated in completing the programme.

The acreage estimated for spraying during 1958 comprises all fields in the lower part of the estate with a history of mite attacks, less the acreage scheduled for pruning in this area.

Some Factors Affecting the Incidence and Control of Mite Attacks.—

(a) Weather.—It is known that during a prolonged spell of wet weather, the damage caused by mites is reduced to negligible proportions, even though the mites themselves continue to exist and breed. The physical effect of rain water on the foliage is of lesser importance than the moisture available to the root system, and thence in the form of sap in the leaf. If during dry weather, the loss of moisture in the soil can be reduced to a minimum by the use of thatching material in excess of the amount normally laid down, some diminishment of the damage might be expected.

(b) Chemical factors and/or pH value of the soil.—It has been noticed that certain areas of tea are more severely attacked by mites than others, although there does not appear to be any difference between the water holding property of either area, nor does shade differ appreciably in type or density. This would suggest that either the soil pH value or other chemical property is the influencing factor.

A reference has been found in an agricultural publication of 1928 (1) to the reduction of red spider attacks on tea by the application of sulphur to the soil. It is not, however, clear whether the reduction of red spider was due to the lowering of the soil pH value or to the systemic effect of the sulphur on the mite.

It has, however, been found in another district that whereas the soil pH value is decreasing, the severity of scarlet mite attacks is increasing.

(c) Copper spraying.—Although no direct relation between copper spraying for blister blight control and the recent increase of mites has been found, some connection is thought to exist.

A microscopic examination of village tea where no copper has ever been applied, on the boundary of the estate, has revealed no scarlet mites, though purple and yellow mites were seen. The adjoining area of estate tea which is regularly sprayed with copper, is heavily infested with scarlet mite.

(d) Shade.— Both *Grevillea* and *Albizzia moluccana* are known to be hosts to scarlet mite. If it can be proved that re-infestation of tea in which mites have been eliminated by either spraying or pruning, is due to infested leaf-fall, then consideration might be given to the gradual substitution of *Albizzia sumatrana,* which is resistant to scarlet mite, for the *moluccana* variety. No answer is, however, apparent in the case of the *Grevillea,* and this is too valuable a tree to be lightly discarded. Periodic pollarding followed by bark ring traps might be considered, to prevent any migration to newly formed foliage.

(e) Elevation and Pruning.—As mentioned earlier in these notes, the incidence of attacks by the various mites differs at different elevations. A certain amount of natural control can be afforded in the case of yellow mite by an adjustment of pruning dates.

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1. Mann, H. H. (1935). Tea Soils. Technical Communication No. 32 Imperial Bureau of Soil Science.

REVIEW

THE CULTURE AND MARKETING OF TEA
BY C. R. HARLER, SECOND EDITION
OXFORD UNIVERSITY PRESS. 1956. 25/-

Few readers will need introduction to Dr. Harler, who has spent most of his working life in tea and was for many years a scientific officer in the Indian Tea Association's experiment station in Assam.

This edition appears at an opportune time when the industry is on the verge of fundamental changes in tea culture and manufacture. Coming from one who has had wide and considerable experience of 'this healthful herb' this book serves as a useful background for future developments, particularly for those who are new to tea. It deals with most of the things that may still appear rather vague even to those connected with tea, and the author has succeeded in throwing a great deal of light on many phases of the industry, known to very few.

In his search for material Dr. Harler, as he admits it, has freely made use of the information published in various publications of the research institutes in different countries where tea is grown. He has thus assembled as many facts as are ascertainable and has filled all the details into a fascinating story of tea.

The twenty chapters are well chosen and logically arranged. Chapter I dealing with the plant gives useful and interesting information on its habitat and the different varieties, which according to the author, can now be classified into four main types. The potentialities of selection are given a prominent place in this chapter, but it is a pity that an important subject such as vegetative propagation is dismissed in a couple of pages.

Chapter II 'climate and the production of tea' might very well have been shortened considerably and made more readable by fewer tables.

The next two chapters make refreshing reading and the author is to be commended on so successfully giving the reader, without being too elaborate, an insight into different types of soils in tea areas and the various methods adopted in the culture and preparation of tea. A very comprehensive subject suitably condensed, which serves as a fitting introduction to Part II of the book.

Part I ends with the chemistry and pharmacology of tea, dealt with rather too briefly, but yet as stimulating to read as the satisfaction derived from a cup of tea.

In Part II, the author goes into more detail, describing the types of tea produced in the tea countries of the world, its culture and manufacture. Most of this section is naturally devoted to the industry in N.E. India with which the author has been associated for a considerable period.

It is satisfying to record that stress is laid on the fact that good tea could only be made from fine leaf and depends primarily on the types of bush grown, a fact which has been known for a number of years but only recently come to be recognised of vital importance by the grower. Also, that orthodox methods of procedure must be followed not only to satisfy trade requirements but to produce a tea which the consumer of tea is accustomed to, is a statement which will explain to the reader why perhaps little progress has so far been made in finding short cuts in the processing of tea. Whatever is done in manufacture the most important requirement is the obtaining of a desirable range of polyphenol condensation compounds without which the brew from black tea would taste so different. The author does not mince words when he acknowledges this.

The last part of the book fills all the gaps necessary to complete the story of this great industry. An insight into the tea trade is given and the non-technical reader may be surprised at the number of terms used to describe tea. The book ends with some useful statistics on production, export and consumption, and finally in Chapter XX with the author's conclusions.

On the whole, the book is a mine of knowledge from which even the casual reader can pick up useful nuggets of information. Not being a text book it should appeal to a wide circle of readers.

Only one major criticism, the reviewer may be pardoned to make, is that the tea industry in Ceylon has not been presented in more detail. Admittedly it is not possible to cover every aspect of tea from Japan to far away Peru in just over 250 pages. Yet Ceylon being the second largest exporter and producer of the finest teas in the world might have been given more recognition.

E. L. K.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD IN THE CHAIRMAN/COMMITTEE ROOM OF THE PLANTERS' ASSOCIATION OF CEYLON, COLOMBO, ON FRIDAY, 7th JUNE, 1957, AT 10-00 A. M.

Present.—Mr. F. Amarasuriya (Chairman), Mr. R. M. Macintyre (Chairman, Agency Section of the Planters' Association), Dr. M. F. Chandraratna, M.B.E. (Director of Agriculture), Senator E. W. Kannangara, C.B.E. (Chairman, Low-Country Products Association), Messrs. B. Mahadeva, C.C.S. (Tea Controller), H. E. Perics, C.C.S., O.B.E. (representing the Minister of Finance), S. Jinadasa, M.P. (representing the House of Representatives), R. C. Scott, C.B.E., W. H. W. Coultas, V. G. W. Ratnayake, M.B.E., A. D. McLeod, G. K. Newton, G. J. Harris, J. L. D. Peiris, A. G. Divitotawela, N. B. Parker, G. B. Portsmouth (Director, T. R. I.) and G. A. D. Kehl (Secretary).

Dr. A. W. R. Joachim, O.B.E., was also present by invitation.

1. Notice convening the meeting was read.

The Chairman referred to the sudden death of Mr. R. H. Wickremasinghe M.B.E, who had served on the Board as an *ex-officio* member representing the Minister of Finance, since 7th February, 1955.

The Director reported that he had sent a wreath to the funeral on behalf of the Board, the staff of the Institute and himself. He read the copy of a letter sent to Mrs. Wickremesinghe.

A vote of condolence was passed in the usual manner.

2. **Minutes of the Board Meeting held on 22nd March, 1957**

The minutes were confirmed.

3. **Matters Arising out of the minutes**

With regard to the position of the Director on the Board Mr. Mahadeva said that he had written to the Minister.

4. **Small Holdings Advisory Service**

(*i*) **Minutes of the Small Holdings Committee Meeting held on 21st March, 1957.**—The minutes were approved.

(*ii*) **Transfer of Service.**—The Chairman reported that the latest arrangements in connection with the transfer of the Service were contained in Circular No. A. 11/57 of 20th May, 1957, which had been issued to members. It will be noted that the transfer had been postponed until the 1st January, 1958.

Mr. Mahadeva informed the meeting that a formal amendment to the Tea Control Act would be required in order to regularise the payment of the yearly grant of Rs. 350,000/- from the Tea Research Institute.

After some discussion it was agreed that the transfer of the Small Holdings Advisory Service be made on the terms set out in Circular No. A. 11/57 of 20th May, 1957, and further that the determination of the partition of Assets be referred to the Finance Committee.

5. **Minutes of the Estates & Experimental Committee Meeting held on 11th May, 1957**

(i) The release of funds totalling Rs. 12,178/50, which had been recommended by the Committee, was approved.

(ii) The Chairman drew members' attention to the resolution which had been submitted by the Committee on page 5 of the minutes. Considerable discussion ensued and it was finally agreed, on the proposal of Mr. Scott, seconded by Mr. Coultas, to appoint a new Committee consisting of the Chairman (*ex-officio*) and Messrs. B. Mahadeva, R. M. Macintyre, J. E. Davidson and R. J. S. Bean to go into the matter. Mr. Mahadeva was appointed Convener and the Committee was to have power to co-opt additional members as required. Their terms of reference would be those of the resolution of the Estate and Experimental Committee.

On the proposal of Mr. Kannangara the minutes were approved.

Mr Harris left the meeting at this stage as he was indisposed.

6. **Minutes of the Meeting of Certain Members of the Board held on 24th May, 1957**

It was reported that the meeting had been convened to deal with certain staff and administrative matters which had been referred back by the Standing Committee, at the meeting held on 8th March, 1957, for discussion between the former members of the Committee of Investigation, namely Messrs. F. Amarasuriya, B. Mahadeva and R. M. Macintyre, and the Director.

The minutes were accepted and the recommendations made therein approved. The additional expenditure of Rs. 1,720/- which would be incurred as a result of the above recommendations was also approved.

7. **Low-Country Sub-Station**

The Chairman referred to the Report submitted by Dr. Joachim, copies of which had been issued to members under cover of Circular No. A. 10/57 of 10th May, 1957. He said Dr. Joachim had been asked to attend the meeting and was present. He congratulated Dr. Joachim on the very full and exhaustive report which, he thought, was the result of a very close study of the whole problem.

The Director said that the proposals contained in the report appeared to fulfil the points raised and suggested that the report be accepted.

The question of providing the finance required for the establishment of the Sub-Station was referred to the Finance Committee.

8. **Finance**

Audited Accounts for 1956 & Auditors' Reports thereon.—It was reported that the Finance Committee had earlier that morning given full consideration to the Audited Accounts and reports.

At the request of the Chairman, Mr. Macintyre outlined the recommendations of the Finance Committee.

It was agreed that the Audited Accounts for 1956 and the Reports thereon be accepted subject to the recommendations of the Finance Committee.

9. **Staff**

(*i*) **Pathologist.**—It was reported that Mr. B. N. Webster had left St. Coombs on 21st May, 1957.

The Director reported that a fresh advertisement for the post of Pathologist had appeared both in the local press and in *Nature* and the *London Times* for the first time on 11th May, 1957. The closing date for applications had been fixed for 22nd June, 1957. The response received to-date was very poor.

(*ii*) **Superintendent, St. Coombs.**—It was reported that Mr. T. B. Pethiyagoda had assumed duties as Superintendent of St. Coombs Estate on 1st May, 1957.

(*iii*) **Research Assistants.**—The Director reported that Mr. D. Calnaido, B.Sc. (Hons.), and Mr. N. Shanmuganathan, B.Sc. (Hons.), were selected for appointment as Research Assistants in Entomology and Pathology respectively and approval for their appointments obtained by Circular No. A. 7/57 of 12th April, 1957. Mr. Calnaido had assumed duties on 1st May, 1957, and Mr. Shanmuganathan on 1st June, 1957.

The minutes of the meeting of the Appointments Sub-Committee held on 9th April, 1957, were approved.

10. **Any Other Business**

Offer under the Colombo Plan of an Adviser on the Mechanisation of tea cultivation.—The Director reported that an offer had been received of the services of a Mr. Blower from the United Kingdom. This was an outcome of an application which had been made as far back as 1953, following Mr. S. J. Wright's report on this aspect of tea cultivation. He said that he thought the usefulness of accepting such an offer now would be very remote and that there were other more important and urgent problems, such as the services of a mechanical engineer for development of factory machinery, which should be given prior consideration.

Dr. Chandraratna said he would like to have particulars of the expert. as he thought he might be of use to the Department of Agriculture. It was agreed that in the circumstances the offer be declined. The meeting terminated at 1.15 p.m. with a vote of thanks to the Chair.

Sgd. G. A. D. Kehl,
Secretary.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD IN THE GENERAL COMMITTEE ROOM OF THE PLANTERS' ASSOCIATION OF CEYLON, 73/1, KOLLUPITIYA ROAD, COLOMBO, AT 9.45 A. M. ON FRIDAY, 10TH JANUARY, 1958.

Present.—Mr. F. Amarasuriya (Chairman), Senator T. Amarasuriya, O.B.E. (Chairman, Planters' Association of Ceylon), Mr. H. E. Peries, O.B.E., (Deputy Secretary to the Treasury, representing the Minister of Finance), Dr. M. F. Chandraratna, M.B.E. (Director of Agriculture), Messrs. B. Mahadeva (Tea Controller), J. L. D. Peiris, R. C. Scott, O.B.E., R. M. Macintyre, G.K. Newton, N. B. Parker, V. G. W. Ratnayaka, M.B.E., A. G. Divitotawela, E. Jayawickreme, N. M. Sanders, R. D. Wedd, J. A. H. Tolhurst (Acting Director) and G.A.D. Kehl (Secretary).

Mr. T. B. Pethiyagoda (Superintendent, St. Coombs) was present by invitation for that part of the meeting which dealt with St. Coombs Estate Estimates.

A telegram from Senator E. W. Kannangara, C.B.E., and a message from Mr. S. Jinadasa, M.P. regretting their inability to attend were tabled.

1. The notice convening the meeting was read.

The Chairman extended a welcome to Messrs. Errol Jayawickreme, R.D. Wedd and N. M. Sanders, who was acting for Mr. W. H. W. Coultas. He also welcomed Senator Kannangara and Mr. G. K. Newton who had resumed their seats on the Board after leave of absence.

Flood Relief.—The Chairman reported that the entire staff of the Institute were making a donation to the National Flood Relief Fund. A contribution from the St. Coombs Estate staff and Labour force had already been forwarded through the Dimbula District Planters' Association.

2. **Minutes of the Meeting of the Board held on 5th September, 1957**

The minutes of the meeting of the Board held on 5th September, 1957, copies of which had been issued to members under cover of Circular No. A. 33/57 on 2nd October, 1957, were confirmed on the proposal of Mr. N. B. Parker, seconded by Mr. B. Mahadeva.

3. **Matters Arising out of the Minutes**

The Chairman stated that as most of the matters arising out of the above minutes had already received the attention of the Standing Committee, they would be dealt with under Item 10 of the Agenda. *viz*: Minutes of the Standing Committee held on 8th November, 1957.

4. **Membership of the Board & Committees**

(*i*) **Board.**

It was reported that:—

(*a*) **Representing the Planters' Association of Ceylon.**—Mr. N. M. Sanders had been nominated by the Planters' Association of Ceylon to act as its representative on the Board during the absence of Mr. W. H. W. Coultas with effect from 17th October, 1957. Mr. Coultas was expected to be on leave until the second half of February, 1958.

Messrs. R. C. Scott, C.B.E., and N. B. Parker had been renominated for a further period of 3 years with effect from 17th December, 1957.

(*b*) **Representing the Low-Country Products Association.**—
Messrs. F. Amarasuriya and J. L. D. Peiris had been renominated for a further period of three years with effect from 19th December, 1957, and Mr. Errol Jayawickreme had been nominated, vice Mr. B. Amarasuriya, also from 19th December, 1957.

(*c*) **Representing the Planters' Association of Ceylon, Agency Section.**

Mr. R. D. Wedd had been nominated, vice Mr. G. J. Harris, with effect from 1st January, 1958.

The Chairman thanked Messrs. B. Amarasuriya and G. J. Harris for the valuable services rendered during their period of office.

He also welcomed the renominated members.

(*ii*) **Committees.**

The following were elected to the undermentioned Committees :—

(*a*) *Finance Committee.*—Mr. J. L. D. Peiris.

(*b*) *Standing Committee.*—Mr. N. M. Sanders to act for Mr. W. H. W. Coultas.

(*c*) *Buildings Committee.*—Messrs. B. Mahadeva, J. L. D. Peiris and W. H. W.Coultas. Mr. Sanders to act for Mr. Coultas.

(*d*) *Low-Country Committee.*—Mr. J. L. D. Peiris.

(*e*) *Appointments Committee.*—Mr. J. L. D. Peiris.

5. Resolution by Senator E. W. Kannangara

As requested by Senator Kannangara his resolution was deferred for consideration at the next meeting of the Board.

6. Minutes of the Finance Committee Meeting held on 5th September, 1957 & 5th December, 1957.

Copies of the Minutes of the Finance Committee meeting held on the 5th September, 1957, which had been issued to members under cover of Circular No. A 32/57 on 24th September, 1957, were accepted on the proposal of Mr. B. Mahadeva, seconded by Mr. H. E. Peries.

The draft minutes of the Finance Committee meeting held on 5th December, which had been issued to members under cover of Circular No. A. 1/58 on 7th January, 1958, were deferred for consideration under item 13 (*d*) of Agenda, *viz:* Estimates for 1958.

7. Minutes of the Low-Country Committee Meetings held on 4th September, 1957 & 7th October, 1957.

Copies of the minutes of the meetings of the Low-country Committee held on 4th September, 1957, and 7th October, 1957, had been issued to members under cover of

Circular No. A.31/57 on 24th September, 1957, and Circular No. A. 35/57 on 30th October, 1957, respectively.

On the proposal of Mr. J. L. D. Peiris, seconded by Mr. V. G. W. Ratnayaka, the minutes were accepted.

The Chairman informed members that the existing work in the Low-Country would be continued and a sum of approximately Rs. 175,000/- had been included in the estimates.

8. Minutes of the Co-ordinating Committee Meetings held on 27th September, 1957, and 2nd November, 1957.

Copies of the minutes of the Co-ordinating Committee meetings held on 27th September, 1957, and 2nd November, 1957, had been issued to members under cover of Circular No. A. 34/57 on 24th October, 1957, and Circular No. A. 37/57 on 16th November, 1957, respectively. The Chairman said that these minutes were only records of the proceedings of the Committee and that the final meeting of the Committee would take place shortly, when the Committee's report will be drawn up.

9. Minutes of the Appointments Committee Meetings held on 1st November, 1957 & 14th November, 1957.

Copies of the minutes of the meetings of the Appointments Committee held on 1st November, 1957, and 14th November, 1957, had been issued to members under cover of Circular No. A. 36/57 on 16th November, 1957, and Circular No. A. 39/57 on 29th November, 1957, respectively.

Arising out of the minutes of the latter meeting, it was reported that the following appointment was made :—

Research Assistant in Chemistry.—Mr. M. Selvaratnam, B.Sc., Second-class honours in Chemistry.

The Board confirmed the Committee's recommendation that the period of training at St. Coombs for such officers should be at least two years.

The minutes of both meetings were accepted on the proposal of Mr. V. G. W. Ratnayaka, seconded by Mr. B. Mahadeva.

10. Minutes of the Meeting of the Standing Committee held on 8th November, 1957

Copies of the minutes of the meeting of the Standing Committee held on the 8th November, 1957, had been circulated to members under cover of Circular No. A. 38/57 on 23rd November, 1957.

(*i*) **Page 2, Item 4 (a)—Acting Director.—**

The Chairman referred to the memo submitted by the Acting Director regarding his leave and stated that Mr. Tolhurst had originally agreed to stay beyond his due leave date on account of the position regarding the Directorship of the Institute, but the position had changed quite suddenly.

On behalf of the Board Mr. Macintyre, supported by Senator T. Amarasuriya, sympathised with Mr. Tolhurst and strongly recommended that Mr. Tolhurst be allowed to proceed on leave in early March. Agreed.

The Acting Director thanked the Board for the sympathetic consideration given to his application.

Regarding arrangements for an Acting Director, it was unanimously agreed that Dr. A. W. R. Joachim, O.B.E., be appointed Acting Director for the duration of Mr. Tolhurst's absence on leave.

(*ii*) **Page 3. Item 4** (*b*) **Dr. E. Judenko, Special Research Entomologist.**—The recommendation of the standing committee that Dr. Judenko be allowed to postpone his leave from March to June was approved.

(*iii*) **Page 3. Item 4** (*c*)—**Dr. T. Visser.**—After some discussion the Board approved the Standing Committee's recommendation to allow Dr. Visser to attend the International Horticultural Conference at Nice from 11th to 18th April, 1958.

(*iv*) **Page 3. Item 4** (*d*) **Mr. G. D. Austin—Entomologist.**—The Chairman stated that Mr. Austin's contract had terminated at the end of 1957, but that he had offered to continue for a short period longer if required. It was strongly urged that Mr. Austin be asked to remain in service until the Entomologist had taken over. Agreed.

(*v*) **Page 4. Item 4** (*e*)—**Mr. M. S. Ramaswamy, Research Assistant in Biochemistry.**—The Board approved Mr. Ramaswamy's promotion to Selection Grade of the Intermediate Staff.

(*vi*) **Page 7. Item 5. St Coombs Water Scheme.**—The Board accepted the Standing Committee's recommendation for acceptance of the suggestion made by Mr. Gibbs as regards supervision of stage 2 of the scheme and the purchase of cast iron and galvanised steel pipes direct from the United Kingdom.

(*vii*) **Page 8. Item 6. Insurance.**—After some discussion it was agreed that no change should be made as regards the Institute's insurances as the present arrangements were proving quite satisfactory.

The minutes were approved on the proposal of Mr. B. Mahadeva, seconded by Mr. V. G. W. Ratnayaka.

11. **Minutes of the Experimental and Estate Committee Meeting held on 9th November, 1957.**

Copies of the above minutes had been issued to members under cover of Circular No. A. 40/57 on 29th November, 1957.

The Chairman said that the estate estimates will be dealt with under item 13 (*b*) of the agenda.

The Board approved the recommendation of the Experimental and Estate Committee for Mr. F. H. Kehl to visit Tocklai.

On the proposal of Mr. Divitotawela, seconded by Dr. Chandraratna, the minutes were approved.

12. **Small Holdings Advisory Service**

(*a*) **Transfer.**—As recommended by the Standing Committee on the 8th November, 1957, the *de facto* transfer of the Service with effect from 30th November, 1957, had been carried out on Monday, 2nd December.

Negotiations were ahead to have all leases made out as requested by the Tea Controller. The leases were now in the hands of the Institute's lawyers who had been asked to make the required arrangements.

The *de jure* transfer of the Service came into force as from 1st January, 1958

13. **Finance**

(*a*) **Accounts of the Institute as at 31st October, 1957.**—Copies of the above accounts which had been circulated to members under cover of Circular No. A. 41/57 on 30th November, 1957, were approved.

The Chairman pointed out that the yield from St. Coombs for 1957 was 286,171 lbs. or 1,074 lbs. per acre as compared with 262,348 lbs. and 922 lbs. per acre in 1956, and he congratulated all concerned including the Visiting Agent.

(*b*) **Estimates for 1958.**—The Chairman pointed out that the forecast of the financial position of the Institute as at 31st December, 1957, revealed a satisfactory position.

The position at the end of 1958 would also appear to be quite satisfactory, but it had to be noted that no capital expenditure on new projects had been included pending decisions on the future staffing of the Institute which would involve accommodation.

(*i*) **St. Coombs Estate.**—It was reported that the estate estimates had been scrutinised both by the Experimental and Estate Committee and the Finance Committee.

It will be noted that the estimates were approved subject to certain provisos which required the attention of the Visiting Agent on his return.

After some discussion the estimates were approved subject to the items mentioned by the Visiting Agent.

(*ii*) **Research Estimates.**—The research estimates were approved on the proposal of Mr. Macintyre seconded by Mr. R. C. Scott, subject to the amendments recommended by the Finance Committee.

The minutes of the meeting of the Finance Committee held on 5th December, 1957, were accepted.

14. **Staff**

Appointments.—Reported that the following appointments had been made:—

V. A. Rangalla, Library Clerk, Junior Staff Grade II.

Mr. Rangalla assumed duties on the 3rd December.

T. S. Nathan, Assistant, Chemistry Department, Junior Staff, Grade I.

N. E. L. Ponnuswamy, Assistant, Plant Physiology Department, Junior Staff, Grade I.

E. P. W. Fernando, Assistant, Entomology Department, Junior Staff Grade II.

S. Samarasingham, Assistant, Plant Physiology Department, Junior Staff, Grade II.

The above named assumed duties on 3rd of January, 1958.

15. **Any Other Business**

Statutory dates for meetings in 1958.—The Chairman informed members of the following statutory dates of the Standing Committee and Board meetings :—

Standing Committee:—7th February, 9th May, 9th August and 7th November.

Board:—7th March, 6th June, 5th September and 5th December.

It was agreed that the next meeting of the Board to be held on 7th March should be held at 9.30 a.m. at St. Coombs.

Before concluding the meeting Mr. Macintyre again, on behalf of the Board, thanked Mr. Tolhurst for having carried out the arduous duties of Acting Director and he hoped that Mr. Tolhurst would be benefited by the rest and attention he would receive while on leave. Mr. Ratnayaka supported Mr. Macintyre and wished Mr. Tolhurst a happy holiday.

The meeting terminated at 1.45 p.m. with a vote of thanks to the chair.

Sgd. G. A. D. KEHL,
Secretary.

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